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Leaving the Lawyers Out

ABSENCE of lawyers from a recent conference between city officials of Chicago and the Chicago & Northwestern Railway is said to be accountable primarily for a speedy agreement on the adjustment of costs of the Franklin Street bridge improvements. William R. Morehouse, commissioner of public works, debarred lawyers and called in the president of the road, two aldermen and the engineers of the city and railroad. Forty-five minutes' time only was consumed, truly a good record. The president, backed by his engineers, knew what was a fair bargain, and the adjustment, therefore, came quickly without the quibbling and technical legal persiflage with which the lawyers are wont to clothe negotiations. Many another engineering problem would be well on the way toward solution were the opposing engineers left to agree upon the facts and adjust differences of opinion between themselves instead of intrusting the negotiations to lawyers with little appreciation of the engineering features of the problem.

Signs for Road Detours

ANY one who has had the disagreeable experience of coming to a line of carpenter's horses across a road, indicating that new work or repairs were in progress, without finding any directions as to the combination of roads by which to regain the main highway beyond the construction work, will say a hearty "Amen" to the suggestion that highway engineers make it their business to explain combinations of detour roads clearly. It would not be much of an effort to have a suitable sign painted, showing both by diagram and description just how one should proceed. When there are alternative routes, their length and conditions should be noted. So far as this journal knows very few of the States make it a practice to thus designate detour routes. Unfortunately the guide books usually carried by automobilists give comparatively little information about the side roads, which must, as a rule, be followed to avoid construction work. The highway engineer's business, as this journal sees it, is not only to take care of the technical problems of road work, but, in general, to provide for the movement of traffic as cheaply and as comfortably as is consistent with the financial limitations imposed by the volume and type of traffic and the financial condition of the community. It is, therefore, entirely within his scope—and, in fact, part of his duty—to render the use of the trafficways he builds as satisfactory as possible even from the standpoint of directing those who use the roads. A little thoughtfulness in this connection will go a long way toward making fast friends; and wide popular support is a type of approval which no highway official can afford to ignore.

Smoke Prevention at Boston

CONTROL of smoke emission appears to be making excellent progress at Boston, according to the latest annual report of the Massachusetts Gas and Electric Light Commission. Last year 41,680 recorded observations were made, against 35,424 in 1913, and while the respective numbers of violations noted were 1334 and 1225, the increasing strictness of the inspection no less than the proportional decrease in excessive emissions indicate the success of this supervision. Locomotive stacks at roundhouses appear to be giving the board some concern, but improvements in this direction are anticipated. As an incidental feature of the work, the inspectors of the board have been able to aid fuel users materially in the direction of securing more efficient as well as smokeless combustion, and a gratifying co-operation has been evident among all parties in interest. Economical and smokeless firing go close together, and nothing better indicates the success of thorough inspection, combined with intelligent study of firing conditions, than the fact that only one of the stacks visited by the chief of the department remained an offender at the close of the year. Two fines were imposed by the courts during the year for continued violation; but in the great majority of cases, fuel users are showing themselves heartily anxious to co-operate with the board in this important service.

The Rail Problem

EMPHASIS is again laid on the seriousness of the rail problem by the recent discussion of the subject before the New York Railroad Club, abstracted on page 106 of this issue. The revolutionary proposal of Mr. Lindenthal to experiment with U-shaped double-webbed rails, with a view to their possible adoption, did not meet with the approval of the other engineers who joined in the discussion. Yet it is a deplorable condition, as Mr. Lindenthal pointed out and all agreed, that so essential a part of the railroad structure can fail utterly in service, without warning or seeming provocation, and that eternal vigilance on the part of track men must be depended on to prevent daily disaster. Whether the ultimate solution of the problem will be a radical change in the size and shape of the rail section, its chemistry, the mechanical processes of rolling, or a combination of all these, must be determined by those who are making the problem a life study. Even these experts, however, cannot make much progress without money for experimental purposes. It is unfortunate that the American Railway Association, dissatisfied with results, has withdrawn its financial support from the rail committee of the American Railway Engineering Association. It behooves the members of the latter organization, as well as all others cognizant of the technical seriousness of the situation, to use their influence to the utmost to convince the railroad managers that the rail problem must be solved and that it can only be solved by continued, costly and, to a large extent, unproductive experimentation.

Successful Ice Fighting

LAST WEEK Mr. Allner, superintendent of the Pennsylvania Water & Power Company, detailed the instructions which have been prepared to guide the operators of the Holtwood hydroelectric plant in their endeavors to keep the plant in operation when its continuance in service is threatened by frazil ice. The natural inquiry, following a reading of such instructions, is as to the success of the procedure laid down. This inquiry is answered fully in a second article by Mr. Allner, printed on page 113 of this issue. His frank discussion of the difficulties encountered and of the improvements which will be adopted next year make the article of unusual value to operators—and designers, too—of hydroelectric plants. It must be expected that in working out a procedure such as this some details of standard equipment, put to a new use, will have to be changed. Of special interest are the means for detecting the first sign of frazil. The outstanding feature, however, is that the plant was kept in operation and that the rules promulgated have proved adequate to meet the situation. It must not be gathered from the length of the instructions and the amount of detailed information given by Mr. Allner that frazil ice disturbances are frequent or to be regarded as unusually alarming. Such is not the case. A close reading of the article in this issue shows that frazil ice runs are rather infrequent. The attention given to methods of fighting them is merely an evidence of the care with which the operation of the plant has been worked out and of the determination of the company to leave nothing undone to help attain the desideratum—uninterrupted operation.

Safety First in Bridge Building

IT IS significant to note that in the largest of modern bridge-erection problems, the safety and convenience of the workmen are recognized as essential for efficiency. Attention has already been called to the riveting stages and pin-driving bridges being used by the American Bridge Company in the erection of the Hell Gate arch. It will be recognized, moreover, from the description of erection methods on the Quebec Bridge, on page 96 of this issue, that the St. Lawrence Bridge Company is second to no erection organization in caring for the safety and efficiency of men engaged in what must always be considered a dangerous class of work. This tendency means that the human factor in construction is beginning to receive some of the attention it deserves. Have a care for the men's safety, free them from the anxiety of working in needlessly exposed places, make it easy for them to get to their work and convenient for them to do it, and long steps have been taken toward winning their loyalty and arousing pride in their work that cuts both ways. The men earn more for the contractor and more for themselves, the while doing far better work. Aside from this significant tendency, and from the fact that the Quebec Bridge will be the largest ever built, both in length of span and in weight of metal in the main spans, the new erection problems, created largely by the extraordinary distances between pin points in the main trusses, and the skill shown in solving them, for which the engineers connected with the bridge deserve the highest credit, will be of great interest to erection engineers and contractors. There is no doubt that the erection of this bridge is the most novel and interesting feat of its kind attempted since the Forth bridge was completed.

Home Rule in Road Work

"WHAT we want is home rule," oratorically declared an Illinois country politician recently, when, by taking advantage of a small legislative attendance, he blocked the passage of a bill appropriating the unexpended balance in the State road fund for the construction of hard roads until the Senate should pass a bill giving county officials more authority. He and other legislators of his type might do well to heed the experience of other States in which the small local official has been given the chance to express his views or exercise his authority.

Special effort was made in Wisconsin to obtain suggestions from town chairmen as to plans submitted for road work, but the response was extremely meager. The State Highway Commission states that with plans for a total of 2527 miles of roads submitted to the town chairmen, with an urgent request for suggestions and criticisms, not more than fifty such suggestions were received. Most of the town chairmen either do not take the trouble to look over the plans and the road to be improved, or are satisfied with the plans. Some of them prefer to register their objections to the construction after it is finished rather than to make helpful suggestions in time to prevent mistakes.

Kansas has "home rule" in its road building; in fact too much, as is evidenced by the following statement by W. S. Gearhart, State engineer: "The lack of an adequate system of road management largely accounts for the waste of public funds. Kansas has entirely too many inexperienced, incompetent, inefficient road officials. There are four county officials for each of the 105 counties and an average of about seven township road officials for each of the 1492 townships, which makes a total of about 10,900 road officials to superintend the construction and maintenance of 108,500 miles of highways, or about one for each 10 miles of road. One-third this number of officials could manage the work much more economically and much more satisfactorily from every standpoint."

A centralized body like a State highway commission, from its very nature, acts as a clearing house for the collection of information and impressions as to improved methods of doing work and is in a position to take a broad view, to sift the wheat from the chaff and pass on to the local authorities the experiences not only of other counties but also of other States. There must always be some measure of local control of the minor highways. In fact it is well that it should be so, in order that the people may, by direct participation, have a concern for their road work and its cost. But more and more every feature of road work needs to be brought under the advisory influence, at least, of competent engineers. State-aid now plays an important part in the highway activities of counties, with the salutary influence on the county officials due to contact with the State's engineering corps. Likewise some measure of county control, in a technical way, would be of immense benefit to the township highway systems. In too many States the township road supervisors follow their own crude theories of road construction and maintenance, much to the detriment of the resulting highways.

Standards for Drinking Water

NOT long ago the U. S. Treasury Department issued an order prescribing certain standards of purity, or, to be more exact, certain limits of permissible impurity, for drinking water furnished by interstate carriers. These regulations were adopted after long deliberation, but they have already been criticized by water experts as being too drastic, and it must be admitted that there are some public water supplies generally regarded as reasonably safe for general use which will fail to meet the requirements. It is even true that some filtered water supplies cannot always comply with the tests demanded. Doubtless the opposition to these standards will grow as their application becomes wider.

Without attempting to comment on the stringency or leniency of the requirements for bacterial purity, it seems proper to point out the great difficulty inherent in the application of any fixed standard. If one studies the bacteriological analyses of the effluent of any well-designed and well-operated filtration plant it will be evident that the numbers of bacteria present are not uniform. Most of them will hover around a certain median figure, but a few will be higher and occasionally one will be very high, due either to a temporary lapse in the efficiency of the filter or to some error of observation. To fix a standard high enough to include these occasional samples would make it too lax; to fix it too close to the median would be too strict. The proper standard would be one which was not exceeded except by a small percentage of the samples. What should be this percentage, one, or five, or ten, or what figure? At present no one can give an answer based on adequate data.

Having decided upon a standard, it is obvious that it cannot be applied to a single sample of water, because this sample may perchance be one of the erratic ones which fall within the small allowable percentage of excesses. The use of the standard is, therefore, a matter of judgment. No water should be condemned on the results of a single sample. The U. S. Treasury standard, therefore, should not be considered as unfair until the manner in which it is used by the authorities has been shown. It is admittedly a tentative standard and subject to change, and is intended to be applied to drinking water only. Water analysts will do well to study carefully the mathematics of these important bacteriological tests.

Another phase of the subject of standards of purity of water supplies should be considered—the influence of custom or local prejudice. The permissible limit of color in water is sometimes said to be 10 or 15 or 20, or thereabouts. Is this arbitrary or local? In regions where colored waters are common it is well known that consumers do not object to water with a fairly high color, to a color that would not be tolerated in some other region. And in the same way consumers who are accustomed to a very soft water object strenuously to even a slight increase in hardness.

To what extent should the standards for water served by interstate carriers be independent of local standards? To require a soft water in a hard-water country would be so difficult as to be practically impossible and, from the standpoint of a drinking water, unnecessary, so far as local travelers are concerned. Yet to subject cross-country travelers alternately to very hard and very soft waters is undesirable.

The more one studies the subject of standards the more difficult it appears to be. The general principle, however, would seem to be axiomatic, that the wider the geographical application of a standard the more lenient it should be. Possibly the outcome will be the adoption of certain general standards of wide application supplemented by local standards appropriate to local conditions.

The Jitney's Wane and Influence

AS was predicted in this journal early this year the jitney craze seems to have passed its height. The downward trend was clearly noticeable on the Pacific Coast as far back as March, but reports from other sections of the country indicate that the experience is being repeated quite generally. It was contended, in the early days of the jitney movement less than a year ago, that large companies would enter the field and with their more efficient management prove a formidable competitor to the street railways. This journal conceded that there was a chance for success with the 5-cent conveyance provided the traffic were dense and the haul only about a mile. Later events, however, lead one to wonder whether, even under this favorable condition, there is likely to be a success sufficiently marked to keep capital in the enterprise.

Recently a well organized company in Washington which had been operating six eighteen-passenger buses of good design over a route from Fifteenth Street and Pennsylvania Avenue, a departmental, business and hotel center, to Sixteenth and U Streets, traversing one of the best residential districts of the city, went into the hands of a receiver. The maximum haul for a 5-cent or a six-for-a-quarter fare was 1½ miles. The traffic has amounted to as many as 65,000 passengers a month, but the line could not be made to pay even with the most economical, not to say parsimonious, management. It is simply a case of trying to give a service for less than cost, cost in this case meaning proper allowances not only for operating expenses, but also for interest, depreciation, maintenance and a fair return on the capital. In this case the failure is all the more noteworthy because the enterprise was well backed financially and had a particularly good route. A similar experience, though the conditions were not quite so favorable, was recorded at Los Angeles some months ago when a bus company that had been in operation for three years went into the hands of a receiver.

Nevertheless, during its short but very active career, the jitney has made inroads upon the electric railway industry aside from the hole due to it in the financial account. Street railway operators have been wondering whether it would not be advisable to build a light, small-capacity car, which could be run with one man and at frequent intervals. This suggestion was made editorially in this journal, April 24, page 513. It has very manifest advantages, because of the smaller number of stops (a matter directly related to the passenger-carrying capacity) and the shorter time taken in starting and stopping. Even beyond this proposal, which in itself is a far step, since the tendency in street-railway car design has been toward longer and heavier units, the proposal has been seriously made that the zone system be adopted, offering a lower fare for the short haul traffic in a central business zone. In fact, this method is now being used by the British Columbia Electric Railway. While for its ordinary service a 5-cent fare is charged, a special non-transfer ticket is sold at the rate of eight for 25 cents, good only within the city limits of Vancouver and of Victoria. At Milwaukee the zone system has also been proposed in order that, with a reduced rate, the number of passengers may be increased, thus setting up competition with the jitney and encouraging those to ride who now walk for short distances.

Considering the attention being given to these two possible means of competing with jitney service one need not be surprised at developments in either direction in the near future. The jitney would then not have been without service even to the electric railway industry itself.

Recent Progress in the Development of Power

POWER plant engineering maintains a steady advance toward more efficient installations. Progress is being made along many lines, assumed to be thoroughly standardized by persons not intimately associated with this field of work, as even the casual reader of this year's report of the National Electric Light Association's committee on prime movers will discover. Noteworthy developments are under way in all departments of power production, but at present chief interest attaches to the boiler plant, to auxiliary equipment long considered settled in design, and to refinements in hydraulic measurement.

Improvements in automatic-stoker design have lately been realized which mean more convenient installations from the space standpoint, besides greater assurance of smokeless combustion and exceedingly efficient utilization of fuels of varying grades. The increasing size of boilers justifies many refinements of design and measurement which would hardly be warranted in small plants, and scientific management is coming to be the order of the day in the best boiler rooms. With large units goes a complete equipment of indicating and recording instruments which ultimately will put the "steam end" of an installation on a far higher plane of service than has previously been realized.

By the subdivision of economizers in certain cases, so that each boiler has its own section, feed water temperatures have been increased advantageously and many of the difficulties associated with single economizers of large size eliminated. Exactly how far to push feed-water heating by economizers depends on investment cost, depreciation, operating expense, space requirements and the economy obtained, each case being a separate engineering problem.

With the present tendency to increase the operating pressure of boilers, it is evident that some change of materials away from cast-iron will have to be made in economizer construction, since the feed-line pressure is rapidly approaching 300 lb. per square inch in advanced installations. Special attention must also be given to the study of ash fusibility, to the effect of slags on furnace linings, to improvements in the methods of sampling flue gases for analysis, and to the prevention of damage to boilers from water-treating compounds containing carbonate of soda. It is anticipated that a bulletin on the last topic will soon be issued by the Engineering Experiment Station of the University of Illinois, in view of an investigation of these troubles conducted by Dr. W. F. M. Goss.

The most notable point in steam-turbine development of late is the large size of units which have been installed. No revolutionary changes in design have lately been brought out, but it is notable that the economy of turbines has been improved from 10 to 20 per cent in the past three years, and that the service of even the largest machines is proving most satisfactory. The tendency in station design where the loads suffice is to provide very large units for handling the bulk of the service, carrying the shorter duration peaks on the older and less efficient apparatus. Turbines of 30,000-kw. rating are proving as reliable as much smaller units. The amount of power involved in these immense machines justifies the utmost refinement of design, not only in relation to turbines and generators, but to auxiliaries, and particularly to condensing equipment.

Many high-class steam plants are still equipped with condensing apparatus which on the builders' rating cannot yield a vacuum within 0.5 in. as high as is easily possible with a properly designed condenser, and this loss amounts to hundreds of thousands of dollars annually. Condenser manufacturers are now fortunately prepared to deliver equipment in which the loss of pressure of the steam in passing through the tubes is greatly reduced, and the advances in detailed design in this long-standardized apparatus are most encouraging to the seeker of high over-all plant efficiency. Pumps are also coming to the front in efficiency studies, and at last the immense importance of saving heat units in the station basement is receiving due recognition.

The omission of regular measurements in any important department of power-station service is likely before long to be a thing of the past in all well conducted plants. Whether for tests or routine operation, engineers are no longer content to let large quantities of water, steam, fuel and oil pass through cycles of service without commercially accurate measurements, either of the recording or of the indicating type. The measurement of condenser-tube leakage by an electrical resistance method, the use of chemical analyses to determine the amount of water discharged by wheels in hydroelectric stations, renewed appreciation of the better known means of checking the costly quantities which may be looked upon as the raw material of power production, and the adaptation of special recorders and regulators to draft measurement and control, all indicate the interest prevalent in securing all possible data regarding power production. As for prime movers, the steam turbine and the reciprocating engine are to-day far ahead of the gas engine in development, and the advance of the crude-oil engine appears to be rapid in the small-power field where independent service is required. The steam turbine bids fair to be the most conspicuous prime mover for some years, and with the development of still larger plants for wide-area service, interesting data as to economy of production on a great scale will become available.

New Methods Evolved in Building World's Largest Bridge

Quebec Erection Takes Care of Members Spliced Between Panel Points by "Flying Falsework" and Erection Trusses—Travelers Unique for Size and Central Operating Control

REMARKABLE erection problems solved by unique and effective methods characterize at every turn the greatest bridge-building undertaking that has ever been attempted. The main members of the Quebec Bridge are so huge that most of them have to be spliced between panel points, and these spliced halves further split lengthwise into two and even four parts for shipment and erection. The field work of fitting these parts together was only made possible by shop work of unprecedented accuracy. This splicing also made necessary extraordinary means of support between panel points for many of these members during erection.

A vertical hoisting range of 320 ft. was required of the erection tools, within which height 90-ton members must not only be handled, but handled in pairs, and with speed and accuracy. The size and weight of the trusses made it desirable to have erection progress on both sides of the bridge exactly simultaneous. This condition has been met and turned to positive advantage.

To deliver material to the piers at the river's edge for simultaneous erection of the anchor and channel arms would have required expensive trestles and a double outlay for erection plant. On the other hand, to erect the anchor arms first has required heavy falsework, some of which at least must remain in place until the river work is well along, since the top chords of the bridge are tension members, and the stress in them could not be reversed without going to great expense in their construction.

ORDER OF ERECTION ON ANCHOR ARM

An account of the erection of the north anchor arm, describing the traveler tracks, and the erection provision for deformation camber, was published in the Engineering Record of Jan. 16, 1915, page 80, and this erection will only be outlined here. The floor system of the north anchor arm was erected on interior falsework consisting of steel towers, topped by heavy plate girders on which the floorbeams of the bridge rest directly. The traveler, running on outside tracks on this floor system, completed this operation from abutment to pier. It then moved back, setting steel columns at each panel point under each truss and erecting the bottom chord as it went. It next traveled back to the pier, the move being made in a few hours, and began erecting each truss to the subpanel points above the floor system. The floorbeams were then connected to the trusses and no longer required the support of the first set of staging. The traveler then erected the upper part of the trusses, completing the span as it moved out for the last time. The falsework that had carried the floor system was removed behind it. This was promptly shipped across the river and re-erected under the south traveler, which had just been set on the south abutment.

The bank on the south side is higher than that under the north anchor arm, but the steel towers of the falsework were designed so that a section unbolted and removed from each left them the proper length for their new positions. This interior falsework weighs 2500 tons, while the outer towers under the panel points, which must remain in place until the river arm is erected, and which alone had to be duplicated for the south anchor arm, weigh but 500 tons.

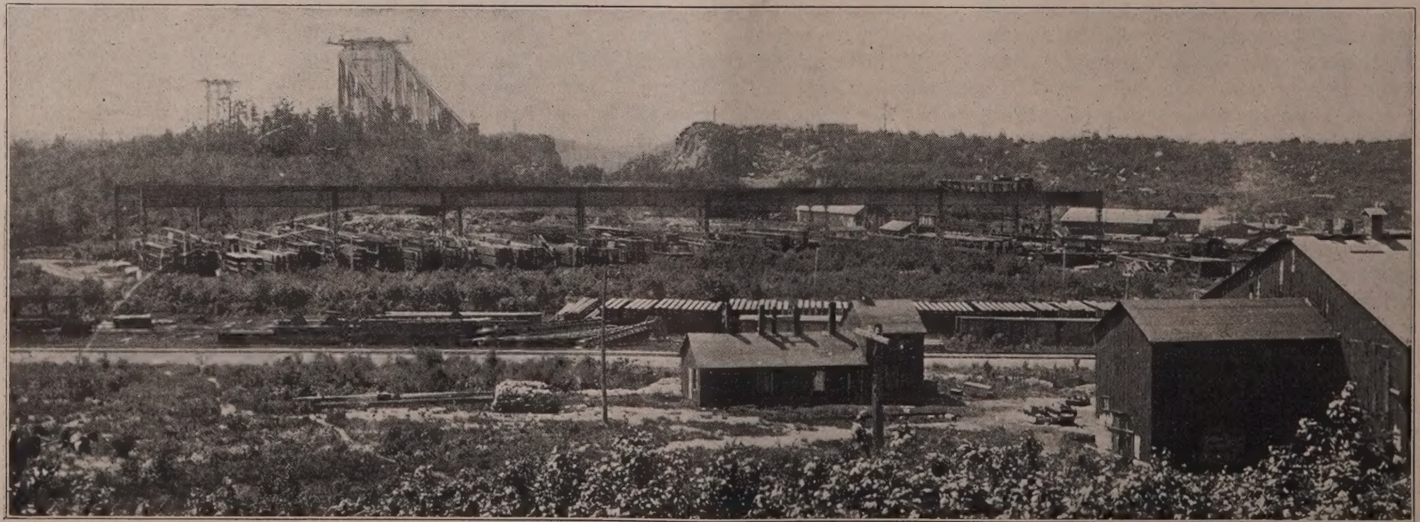
TOWER TRAVELERS EQUIPPED WITH CRANES AND BOOMS

The 1000-ton travelers that are handling this erection are themselves without precedent in design and operation. The main bridge tracks are left clear for steel delivery, and additional girders outside them carry the traveler tracks. A square steel tower, comparable in height and weight of members to the frame of a fifteen-story building, is surmounted by a trussed bridge, overhanging either side of the tower parallel to the main trusses. On top of this bridge are two traveling cranes, each crane carrying two hoisting machines. These main hoists are mounted back to back on the crane girders, and each operates a ten-part fall. In order to keep the heavy machines as near the center of the bridge as possible, the hoisting cables are led over sheaves mounted on trolleys connected to the main hoists and moving with them. An auxiliary crane is mounted on the outer end of each of the main cranes. These auxiliaries are moved by hand power, but are provided with power hoists. They handle pin-driving cages, riveting platforms and light loads.

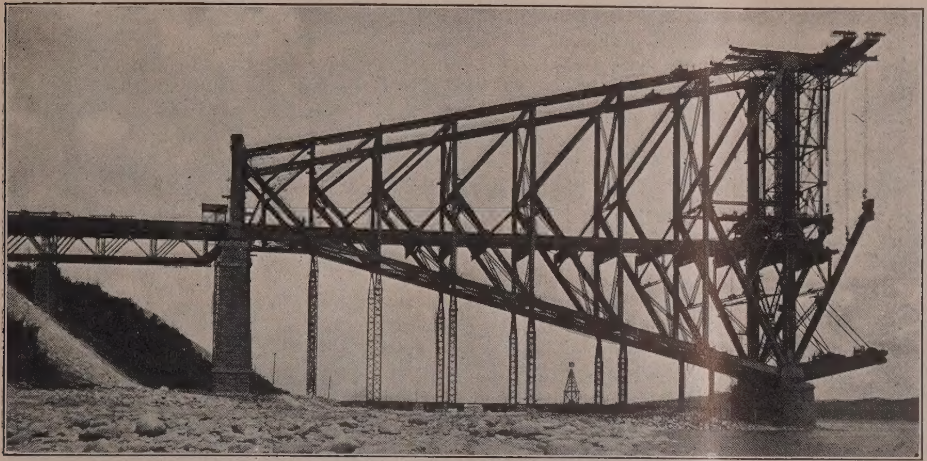
In addition a steel boom is mounted half way up each corner post, each boom swinging by power through 270 deg. The four hoists controlling these booms are banked on the operating deck, over the tracks, on the land side of the traveler. Just under them is the transformer house—for the sole power used for all the erection is electricity from neighboring power developments. At the front of the operating deck is a bridge from which all sides of the traveler are visible. Here are the controls for operating the cranes on top. The motors for the hoisting and traveling motions, however, are mounted on the cranes above, and draw current from a multiple-unit contact system on the deck of the top bridge. A man is stationed at each hoist, with a telephone to the control deck at his elbow, in case of accident. An electric elevator connects the crane deck with the operating deck. The traveler is mounted on four trucks provided with eight wheels each, and is moved by two sets of wire-rope falls, to which two of the derrick falls are luffed for pulling.

With this traveler it is possible to set the corresponding members of each cantilever truss at one operation. The members are loaded each on two short, heavy lorry cars, and pushed out to the bridge head side by side on the main tracks by dinkeys. The front crane is spotted, and its trolleys are run in to the sides of the traveler.

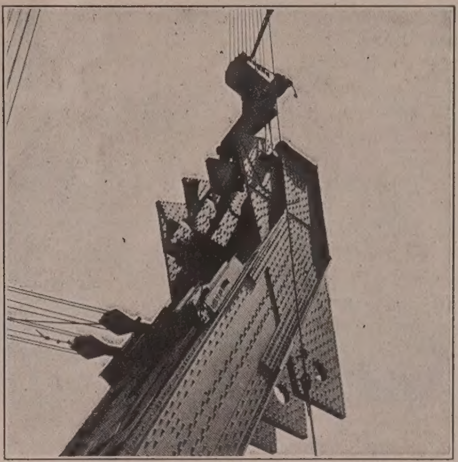
A two-part fleeting tackle is hooked into two open-sheave blocks on the inside of the lifting beams on each set of falls from this forward crane. This fleeting tackle draws in the opposite blocks of the crane to the main tracks. The open-sheave blocks are mounted on a center strap, and the fleeting tackle, consisting of a single long sling of wire



APPROACHING THE BRIDGE BY ROAD, ONE SEES SPREAD OUT BELOW HIM THE STEEL YARD, SERVED BY AN OVERHEAD CRANE



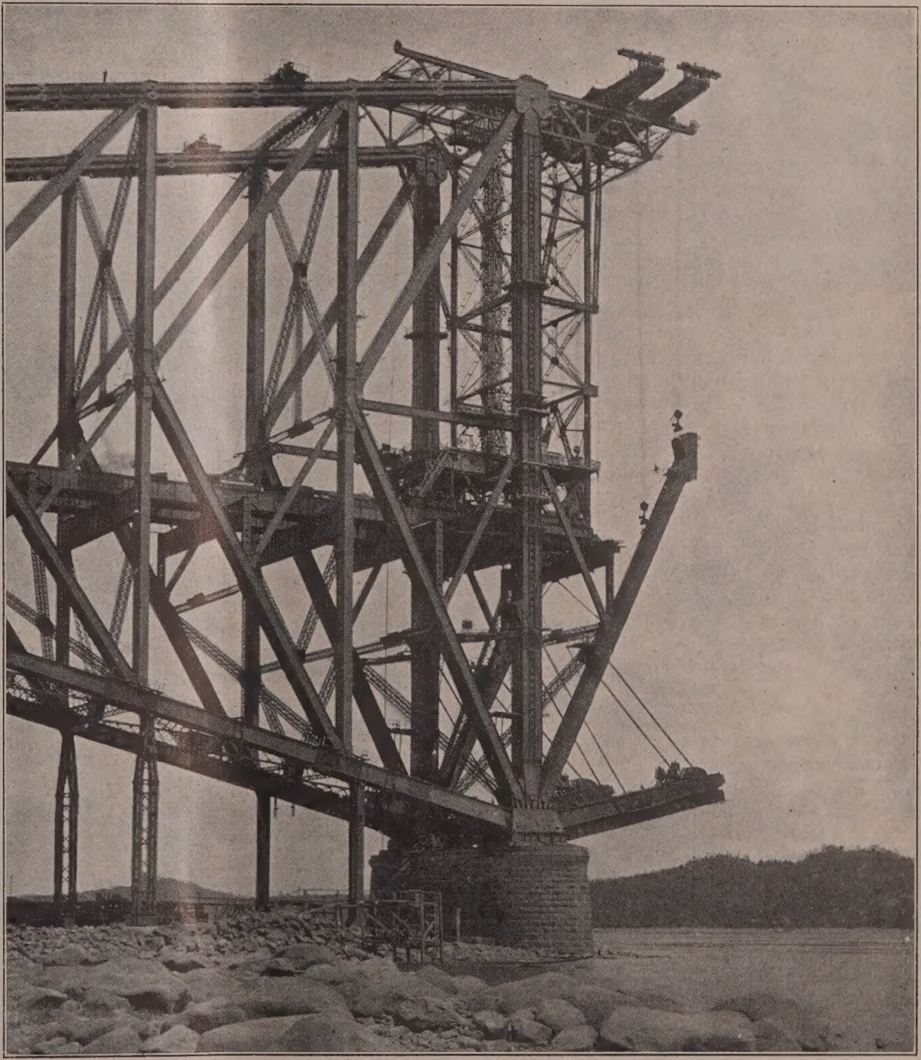
· LIGHT EXTERIOR FALSEWORK SUPPORTS ANCHOR ARM



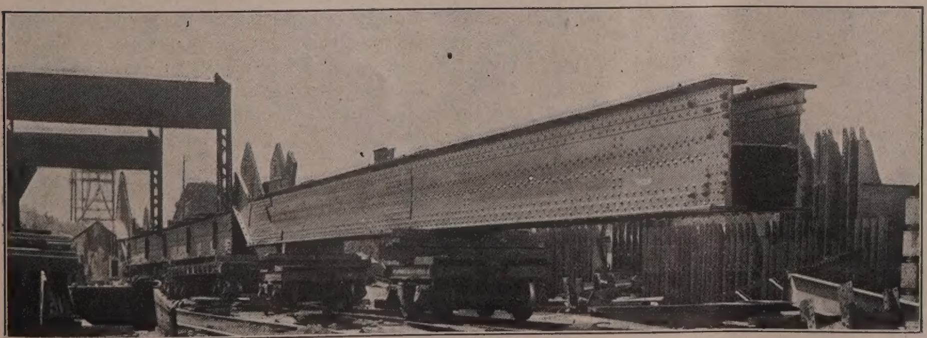
LIFTING-PIN BUSHED IN LARGE HOLE

READY TO SET LAST HALF OF DIAGONAL

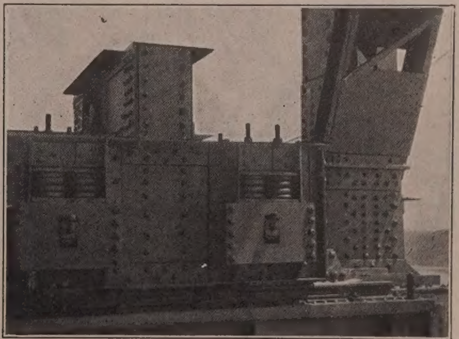
GUIDING HALF OF DIAGONAL INTO PLACE



STARTING OUT OVER RIVER—NOTICE RIVETING PLATFORMS ON TOP CHORD



THESE TWO MEMBERS, SHOWN IN PLACE ABOVE, WERE SET IN 40 MINUTES



ONE TRUCK OF 1000-TON TRAVELER

rope, needs only to have the bights of each part thrown behind the sheaves to engage the blocks. The two ends of the sling, which are on top, are then picked up by one of the forward booms, drawing the main falls in over the track until they can be hooked up to the forward ends of the members to be set. The ends of these members are then raised, and the crane which has hold of them is moved forward.

Meanwhile the derrick holding the fleeting tackle booms out and picks up its load, and the dinkeys push out the rear ends of the two members, which still rest on the rear lorry cars. When the back hitching point of these members comes in front of the traveler tower, where the rear crane can reach it, the falls of this crane are fleeted in by the other forward boom and attached. The members are then raised clear and the cranes run out in position to set them, one raising its ends as the other lowers until the members reach the proper inclination for entering. The fleeting tackles are slacked as soon as the members are in the clear, and are cast off by four men, one of whom rides each lifting beam, by throwing the bights of the slings out of the open sheaves. The members are then lowered or raised to place and connected. With the centralized control of the traveler it is possible to move the cranes and booms together as if they were interlocked, with little signaling and a minimum expense of lung power. The two 73-ton inner halves of the upper half of the lower subdiagonal in the cantilever panel next the north pier were set in this manner inside of 40 min., the operation being timed by a representative of this journal.

Two general types of lifting hitch are used. They are identical, except that in one the lifting pin is bushed in a large pin-hole of a member, while in the other the lifting pin passes through holes in special lifting angles bolted to the back of the member. The first type is shown in the upper right corner of page 97, which photograph also shows the open-sheave block for the fleeting tackle at the right of the lifting beam.

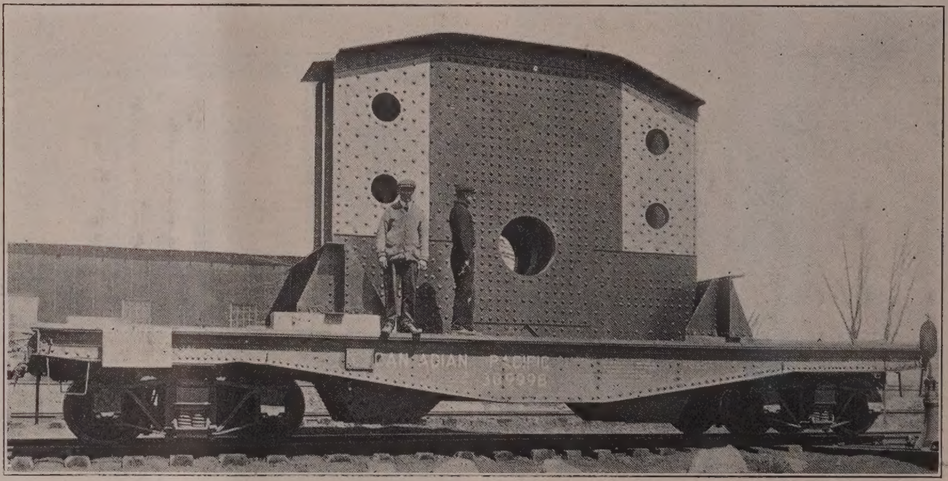
"FLYING FALSEWORK"

The vertical tension members from the subpanel points to the bottom chord are erected after all the diagonals for the panel are in place. To make the pins in these posts, as well as to support the bottom-chord members until they are placed, some kind of falsework from which to jack was practically necessary. Such falsework was also required for another reason. The four parts of each bottom-chord section, spliced in the center, must be erected and matched up on something solid in order to obtain workable results.

A lattice truss, lying flat in the plane of the bottom chord, with a set of heavy girders under each chord member, was devised for this service. Its rear end is supported from the pier for the first panel, and hung from the last bottom-chord panel-points for the rest of the erection. Each side of its "flying" end is hung by two ties, each consisting of one long and several short pairs of eyebars from the last subpanel points erected. The length of these ties is adjusted for each succeeding panel by means of the short eyebars at their lower ends.

On top of the girders of this truss, under the splice and under the outer end of each bottom-chord section, are set four 100-ton hydraulic jacks to make the necessary adjustment. This bridge is raised by the main traveler by means of two pairs of lifting angles, and can be slid forward one panel and reset in a minimum of time.

The lower diagonal members are erected after the first half of the bottom-chord, which is the first member set in each panel. They are supported by guy tackles of wire rope attached to the subpanel points last erected. These tackles are pulled to the required tension by the derrick booms and clamped off with heavy, copper-lined eight-bolt cable clamps before the lifting tackles are loosened. They provide ready adjustment in making the pin connections with the other members meeting at the subpanel point. The outer ends of the bottom-chord members are next set. Then the remaining diagonals of the panel are erected. After the lower vertical members have been placed the upper posts are set, and last the top-chord members are placed. This chord is composed of two lengths and two banks of eyebars. To support the center pin during erection each panel length is packed inside a light riveted truss, which spans the panel, but takes no stress as a member of the bridge. The eyebars are packed in these trusses in the bridge yard, and hauled to the traveler and erected as a unit.



CARS WITH HOLES IN FLOOR REQUIRED FOR TRANSPORTING MANY MEMBERS

SAFETY PROVISIONS NECESSARY FOR RAPID ERECTION

Pin-driving cages, provided with chain blocks for raising and inserting the pins, and holding the ram, are handled by the auxiliary cranes. These cranes also handle the riveting stages. A small electric winch mounted on the top of each main post drags a traveling riveting platform up each chord from panel point to panel point. These two platforms are connected by an ample runway with handrails carried on the top ties between the main trusses. Ample and solid stairways and wide, safe platforms are provided everywhere. Electric elevators are also installed to connect the track level with the ground at each abutment.

As a result of these provisions the men do not have their energies dissipated by holding to precarious perches while trying to work, and are able to get from point to point on the trusses without tiring themselves out in order to get to their work. Attention to these points would, it is believed, pay on any erection, but on a bridge of this size this is essential to progress. The cantilever arms of the bridge must be riveted practically as fast as they are erected, not only for safety, but because erection stresses would displace any riveted connections left drifted or bolted in the ordinary way and make it impossible to rivet them later. On the speed of this work, therefore, hangs the whole erection progress and everything is done to facilitate the riveting.

GOOD SHOP WORK HELPS ERECTION

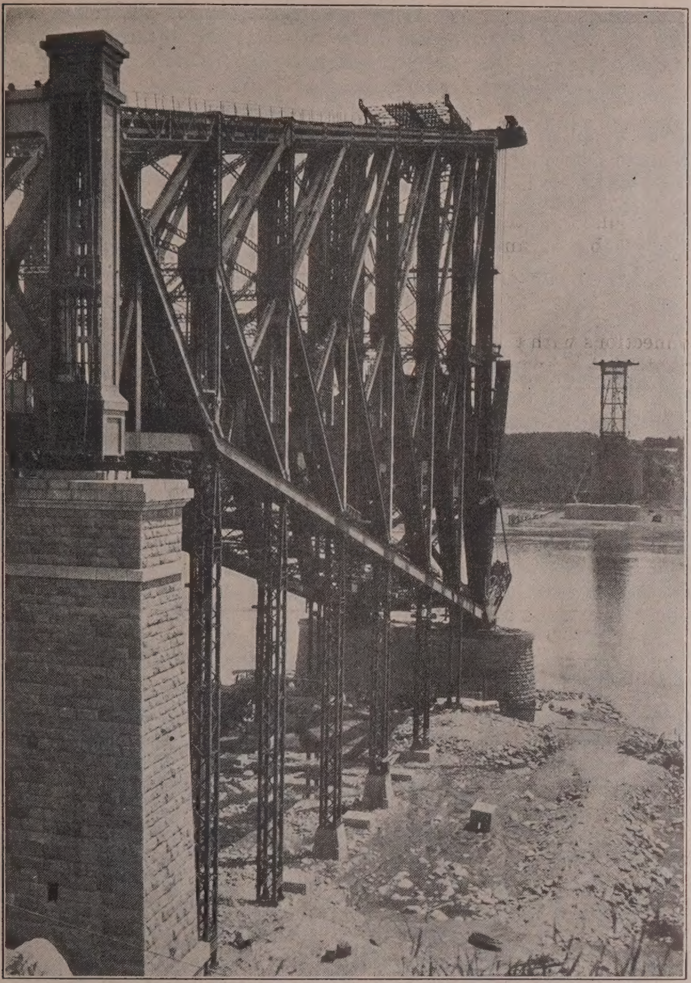
The shop work on these large members is of the finest and the money spent on it has made erection accurate and easy. Although the fact is so incredible that the engineers are loth to be quoted about it, it is a matter of common knowledge at the bridge that the top pins of the main north posts, which are 310 ft. high, and contain six splices, were erected within 0.002 ft. of their calculated elevation for the prevailing weather conditions. Precise checks only confirmed the accuracy of the first measurement.

The north anchor arm has been erected and the north cantilever begun. It and the south anchor arm will doubtless be finished this season, as from 600 to 800 tons a day are being erected by each traveler. The north traveler next year can erect the suspended span. For this purpose its tower will be shortened by taking out two of the panels. The suspended span will be erected on towers, over the water at high tide, but on ground which is bare at low tide. The concrete footings for this falsework are now being placed. Meanwhile the south traveler can erect the south cantilever. The suspended span will then be floated into place and connected at the ends of the cantilever arms. There is nothing to prevent carrying out this program, as fabrication is well advanced. The steel for the north cantilever is practically all at the site, as is that for the south anchor arm, and also some of that for the south cantilever.

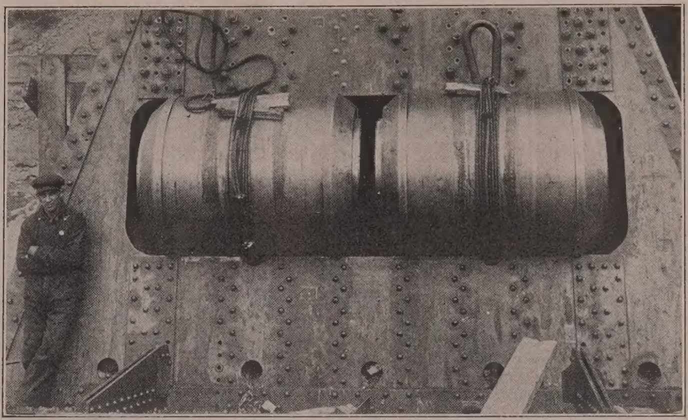
YARDS EQUIPPED WITH 90-TON CRANES

The steel is unloaded by the yard cranes and locomotive cranes in a large yard on each bank of the river, back of the approach tracks to the bridge. Here it is sorted and stacked and the top chords and lighter long diagonals, shipped in sections, are fitted together by the 90-ton traveling yard cranes. Members are loaded up on lorry cars as wanted and hauled to the bridgehead.

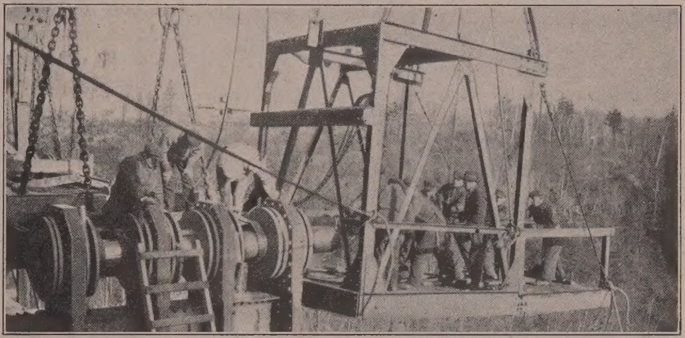
The personnel assembled by the erection of this bridge includes C. N. Monserrat, chairman and chief engineer of the Board of Engineers, Quebec Bridge, Ralph Modjeski and C. C. Schneider, consulting engineers to the board, and H. P. Borden, as-



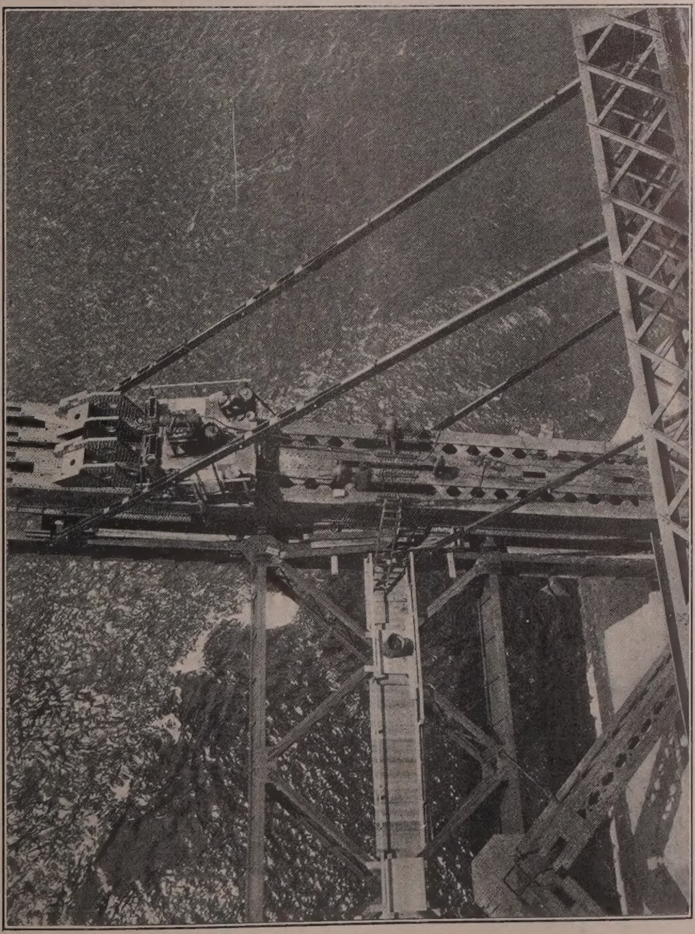
INSIDE FALSEWORK REMOVED IS RE-ERECTED ACROSS RIVER

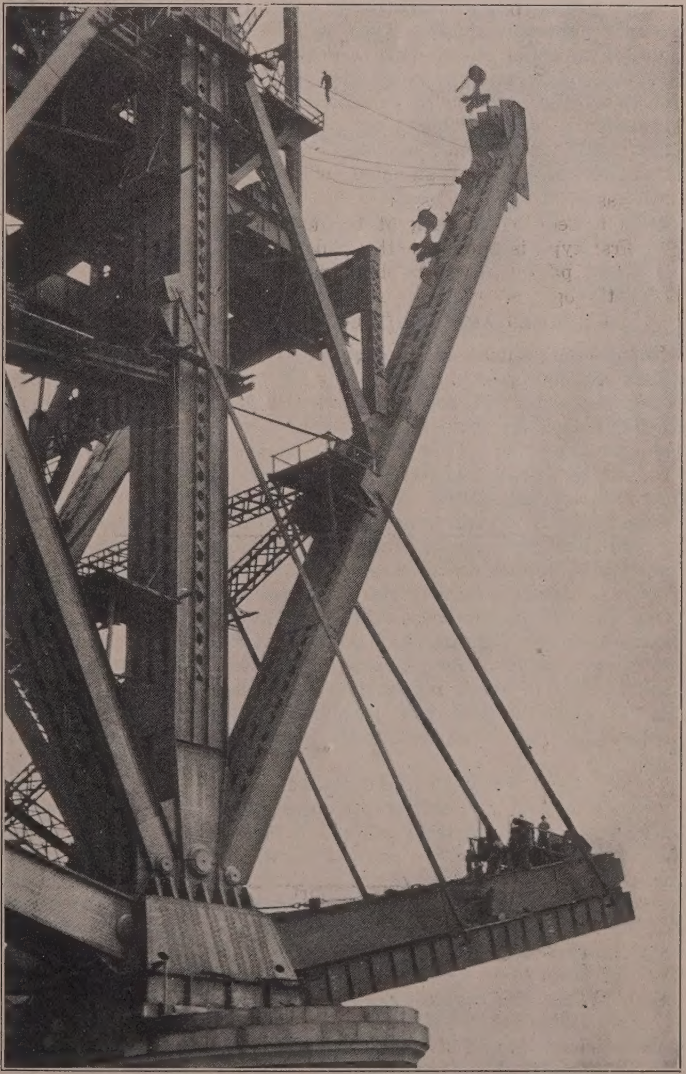


NOTCHES ALLOW REMOVAL OF SLINGS AROUND PINS



DRIVING PIN IN TOP CHORD FROM SPECIAL CAGE





LEFT, "FLYING FALSEWORK" FROM ABOVE—RIGHT, SAME FROM SIDE—NOTE GUY TACKLES AT TOP, ALSO "SAFETY" STAGING sistant to the chief engineer. J. D. Wilkens is in charge of erection for the board as resident engineer at the bridge. With the St. Lawrence Bridge Company, which has the contract for the fabrication and erection of the steel, is associated S. P. Mitchell as consulting engineer. George F. Porter is erection engineer for the contractor, while William Fortune is in charge of all erection as superintendent.

Patrol System for Pennsylvania Road Maintenance

Newly Organized Plan of Caring for State Highways Will Be Inaugurated in August—Force Will Number 190 Men

THE patrol system of maintenance will be established on Pennsylvania State highway routes on Aug. 1. Caretakers will be employed and each man will be assigned to a designated section of highway, for the maintenance and repair of which he will be held responsible. One hundred and ninety men will be placed on this patrol work at the start and the territory covered will extend through forty-six counties. These men will be paid at the rate of from 15 to 20 cents an hour, depending upon the scale of wages for labor in their districts. This will mean an annual expenditure of $120,000, which will figure down to a maintenance cost of $65 a mile a year for the State highways. Maintenance charges heretofore have averaged $500,000 a year.

The patrol men will be directly under the county superintendents. They will be required to make out a daily report of the number of hours they work and these reports will be collected by the county superintendents, who will make out payrolls for the patrol men. As the county superintendents have been supplied with light roadsters, it will be possible for them to keep in close touch with these patrol men on the State highways and to ascertain whether or not the work is being done properly.

Tools and Equipment

Each patrol man will be supplied with tools and equipment necessary for his work and each one will have a small red flag which he will be required to place in a conspicuous position on the road when, for any reason, he is required to leave the roadside during working hours. Hence, either the presence of the patrol man at work or of his flag, indicating temporary absence, will be noticeable during the working hours.

Great care is being exercised in the selection of these patrol men and State Highway Commissioner Cunningham is determined to have none but sober, honest and industrious men in these responsible positions. If it is found that the patrol men are neglecting their work instant dismissal will follow.

The manner in which the caretakers will work is as follows: Along the side of the highway at frequent intervals will be placed small piles of stone chips and gravel, which will be used in patching holes as they are found in the roadway. Barrels, or drums, of bituminous material, containing approximately 45 gal. each, will be placed at intervals of from ¼ to 1/3 mile along the roadside. When the caretaker finds a spot in the road which shows signs of wear, he will place the stones and bituminous material on it, tamping it down carefully and making the surface of the road smooth and even. The caretaker also will look after the edges of the road and will keep the berms clear of weeds and grass and will protect the shoulders of the road to prevent water from getting underneath.

Each patrol man will be supplied with the following outfit: A small combination melting and pouring pot on wheels, a hand-pouring pot, an asphalt tamper, a wheelbarrow, a push brush, a pick, a short-handled and a long-handled shovel, a scythe and snath, a mattock, a rake and a brush hook.

As the patrol men will be under the constant watch of the county superintendent, it will be necessary for them to devote their entire time and attention to the territory to which they are assigned. It is the intention, ultimately, that no man shall have more than 6 miles of roadway to patrol, and this only in sections where the character of the road is such that he can cover it easily and conveniently in a day. In mountainous districts, and in places where peculiar formations make the care of the road more onerous, the patrol distance will be diminished.

Specific Duties Outlined

The following list of the general duties of the patrol men has been prepared by the State Highway Department and each man, as he is engaged, will be furnished with a copy of it and will have his duties explained to him in detail:

Keep drains and ditches open at all times.

Special attention must be given to defects in planking and condition of bridge floors.

Repair all defects in the surface of the road, maintaining same in a true and even condition.

Repair and whitewash guard rails.

Provide protection and red lights in cases of flood washouts, or other emergency conditions.

Remove brush from along the sides of the road, giving special attention to this condition at curves, approaches to railroad crossings, bridges, cross-roads, etc.

Keep the berms or shoulders of the road trimmed up, in that the surface water may be discharged freely from the road surface to the side ditches.

Remove all advertising signs from within the legal limits of the highway.

Paint and keep in first-class condition all department direction and warning signs.

Inspect culverts, head-walls, cribbing, retaining walls, etc., and report defects immediately to the superintendent.

Whitewash large rocks and the bases of poles on narrow sections of highway and at sharp curves. (Spring and fall.) Poles to be whitewashed to a height of 6 ft. above ground.

All equipment, tools and material placed in the charge of each caretaker must be accounted for by him at all times, and tools and equipment kept in thorough repair.

Economic and workmanlike results will be the most important factor recognized by the department.

Attention must be given to the entire section allotted to the caretaker, and work not confined to special and convenient portions.

Daily report postal card must be mailed every evening to the superintendent.

When working on the road caretaker must have flag, which will be provided, displayed at all times near where work is being performed.

When conditions require additional help, team hire, or material of any character, permission must be first secured from the superintendent.

All additional help and team hire must be carried on foreman's daily report form, together with regular pay roll form, etc.

All bills for material, etc., in amounts less than $10, must be covered by superintendent's purchase order; larger amounts by requisition of superintendent and department purchase order.

Caretakers are to be paid an hourly rate, and full value in service will be exacted for every dollar expended.

Caretakers must be courteous and considerate of the interests of the public at all times, and conduct themselves in a manner becoming representatives of the commonwealth.

Sobriety, honesty, industry, good character, and ability are the essentials required, and a failing in any of these will be met by dismissal.

The patrol system for the maintenance of highways is new in Pennsylvania, but has been tried with great success in other States. Chief Engineer William D. Uhler is an enthusiastic believer in this method.

Swinging Blueprint Frame Is Cheap and Efficient

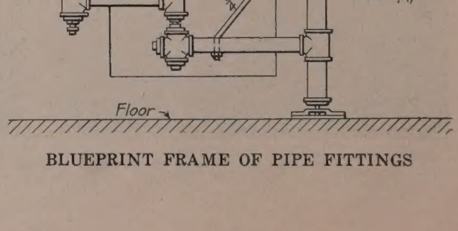
Designed for Use in Window Where Projecting Track or Other Very Noticeable Fixture Would Have Been Objectionable

By FREDERICK W. SALMON

Birmingham, Ala.

THE QUESTION often arises as to how best to arrange to handle a blueprint frame of moderate size, such as 24 x 36 in., which may weigh complete from 60 to 100 lb., and is too heavy to be handled quickly by the "boy" generally used for this purpose. Especially for offices in buildings that can not be cut or permanently altered, some device like the one here shown is needed.

The "specifications" or conditions to be met in this case were (1) that no cutting or permanent alterations of the building should be necessary, (2) that no track or framework should project from the building except just while a print was being made, (3) that the fire escapes should not be used in any way, (4) that any device employed should be neat in appearance at all times, (5) that it should not be expensive, (6) that it should be capable of receiving a "store-made" so-called "standard" blueprint frame and not require one made specially


Ceiling
Outline of Window
4" Pipe (and Fittings
24"x36" Blueprint Frame wt. 65#
3/4 Rd
Column 5" standard black pipe
Floor

BLUEPRINT FRAME OF PIPE FITTINGS

to order, (7) that all parts should be so rigidly secured that there would be no danger of a gust of wind causing any part to break loose and fall to the street below, (8) that the friction and inertia should be so low that a boy could make 100 24 x 36-in. prints per day without getting tired of his job, (9) that the device must not take up much floor space, but must be close to the wall when not in use, (10) that it must not interfere with the janitor's work in cleaning up the office, (11) that wood must not be used if avoidable, (12) that the design must be one that could be produced quickly, preferably from articles that could be bought in the open market almost anywhere and would not require expensive patterns, castings or shopwork, or parts that it would be necessary to send far away for, and (13) that it must permit being set up in about two hours by workmen, as workmen would not be allowed in the building at night, and it interrupted business to have them there in the daytime.

The result was the design shown, which answers all thirteen requirments and in addition eliminates noise and is so extremely stiff that probably a larger frame could be used on it. The cost was as follows:

Materials	$15.00
Drawings, cartage and incidentals	2.25
Blacksmith work	1.30
Machinist work	3.30
Cutting, fitting and assembling pipe	3.75
Erecting in place (2 men 2 hrs)	2.00
Painting	0.60
Total	$27.90

The main precaution to be observed in making such a frame is to draw up the fittings very tight.

Road Oil Is Successfully Applied on Moist Concrete Base

THE California Highway Commission recently made a practical test to see whether moisture on the concrete road base to be oiled affected the quality of the finished wearing surface. A stretch of highway about 1000 ft. long was well hosed in a manner calculated to remove all dust particles, and immediately afterward the oil truck passed over and the usual coat of refined asphaltic road oil at a temperature of about 320 deg. Fahr. was applied.

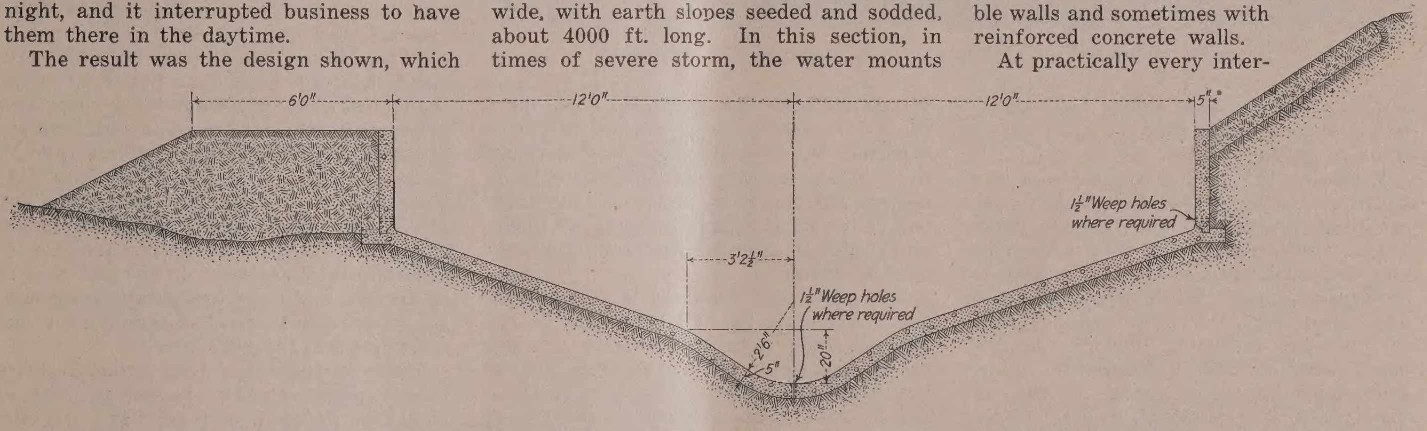
As the oil began to cool on the concrete innumerable air bubbles appeared, giving the surface an appearance very unlike that finished in the usual manner. All the bubbles disappeared, however, within the course of a few hours, and thereafter there was nothing to indicate that this section had been finished differently from the others. The wearing qualities are reported to be the same as of adjacent sections.

Concrete Lining Improves Sewage-Laden Creek

Self-Cleaning Invert Placed in Harrisburg Stream Abates Nuisances in the Business District of the City

By JOEL D. JUSTIN
Principal Engineer, Board of Public Works, Harrisburg

BY MEANS of concrete channel lining for a distance of about 15,000 ft., Paxton Creek, which flows through the business district of Harrisburg, Pa., has been converted from a succession of offensive, stagnant pools into a self-cleaning watercourse from which no nuisances emanate. The improved channel is of two types: One, 24 ft. wide, consists of a curved and sloping concrete invert with side walls 3 ft. high; its length is about 10,400 ft. The other section is a curved and sloping concrete invert 12 ft. wide, with earth slopes seeded and sodded, about 4000 ft. long. In this section, in times of severe storm, the water mounts above the top of the concrete and flows along the protected earth slopes. The extreme lower end of the improvement for a distance of 1200 ft. is not paved with concrete. The inverts are so designed as to secure a maximum velocity of flow during extreme low water conditions. The grade throughout is 0.8 ft. per one thousand. The invert is believed to be practically self-cleaning and it is expected that but slight expense will be required for maintenance.



THE INVERT OF THE CHANNEL LINING IS DESIGNED TO SECURE MAXIMUM VELOCITY OF FLOW DURING PERIODS OF EXTREME LOW WATER

SEWERS DISCHARGE INTO CREEK

Paxton Creek formerly was subject to severe floods. Much damage was done every time heavy rains occurred, but in 1909 the city constructed a flood control reservoir which, in time of storm, by-passes the flood waters, with the exception of approximately 300 sec.-ft., through a large conduit to the Susquehanna River.

The sewers of this section of the city formerly discharged into Paxton Creek, but an intercepting sewer was constructed intercepting the dry-weather flow of these sewers. Even with this improvement the creek channel proved a source of continual nuisance to the abutting properties and residents during the low water season in the summer time. Much refuse was still discharged or thrown in the creek bed, and during the summer time the creek was a continual succession of stagnant pools, giving off a considerable stench and breeding quantities of mosquitoes.

The watershed of the creek at the northern limits of the city is about 18 sq. miles, but owing to the flood control works mentioned above the maximum discharge reaching the creek channel is only 300 sec.-ft.

Just below the northern limits of the city the creek receives the drainage of Asylum Run, a small stream with a drainage area of about 4 sq. miles and very steep watershed having a maximum discharge of 1000 sec.-ft.

ALIGNMENT OF IMPROVED CHANNEL

From time to time work had been done on straightening the channel of Paxton Creek in the built-up portion of the city. Consequently, except for a stretch of 2500 ft. through unimproved property at the upper end of the work where the creek had a winding course, no material changes in alignment were necessary.

The alignment consists of a series of long tangents and gradual curves. There were many private walls varying from 6 to 10 ft. in height along the line of the creek. Some of these walls encroached on the alignment and had to be removed and replaced, sometimes with rubble walls and sometimes with reinforced concrete walls.

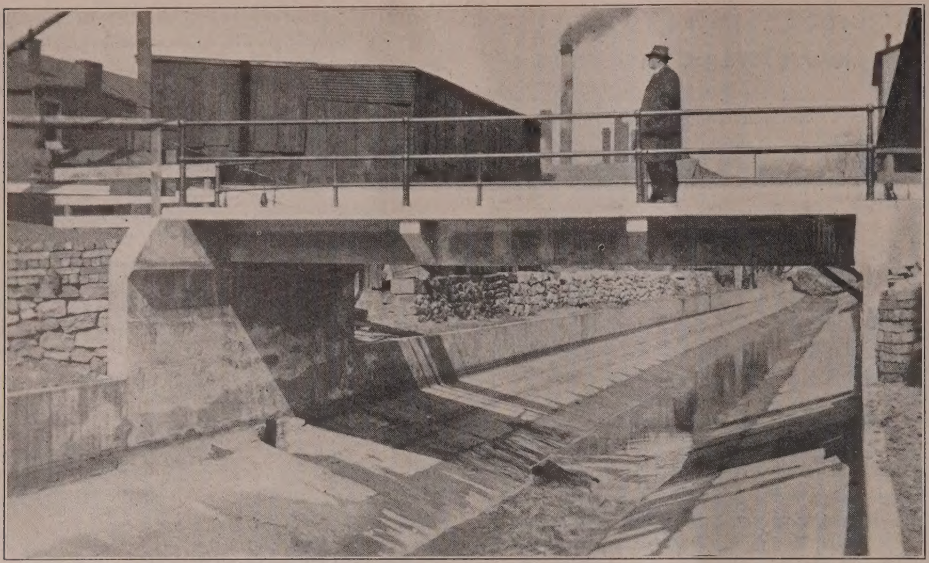
At practically every intercepted street a connection was made to the existing storm overflow sewers which discharge only in time of heavy rains. A section of the intercepting sewer, where it crosses the line of the improvement, had to be torn out and replaced by a siphon consisting of a double line of 30-in. sewer pipe laid in concrete.

A contract was let Sept. 11, 1912, to Karl T. Opperman of Harrisburg, to do this work. Progress made was not satisfactory, and on Oct. 15, 1913, the contractor notified the Board of Public Works that circumstances beyond his control compelled him to abandon the work. The work was then taken up by the Maryland Casualty Company, the bondsman for the contractor, and pushed to completion by the West Construction Company, of Baltimore. Many engineers give bonding companies the reputation for trying to side-step an obligation of this kind by every technicality known to the legal profession, but in this case at any rate the bonding company frankly and promptly acknowledged their obligation and proceeded to take over the work.

TRAVELERS HANDLE EXCAVATION

The excavation was done at the upper end by the original contractor by pick and shovel and by drag-scraper. The West Construction Company used travelers. The excavated material was loaded by hand into buckets, which were then lifted out of the channel by the traveler and dumped at the side of the channel, to be later used in making the embankment.

When it was desired to excavate any particular section a dam was built in the creek and the water diverted to the intercepting sewer, either through one of the overflow



CHANNEL IMPROVEMENT REMOVES ONE OF HARRISBURG'S EYESORES

sewers or by breaking a hole in the interceptor and cutting a short trench from the creek to the interceptor.

Following the traveler there was a gang which excavated the drainage trench in the center of the channel and laid the underdrain, which consisted of 8-in. terra cotta pipe laid with open joints and surrounded by crushed stone. When properly laid the underdrain kept the work clear of water for distances exceeding 1000 ft. At first, due to lack of care in placing the underdrain and the clayey nature of the soil, there was much trouble with water, but this was overcome by entirely surrounding the drain with crushed stone and using care in laying.

The water from the underdrain went to a sump from which it was pumped. At first centrifugal pumps were used, but later two Pulsometers were bought which proved very satisfactory. Set-ups were made from 500 to 1200 ft. apart, according to the distance that the underdrain would work properly. Following the laying of the underdrain, templates for the invert were set and grading completed.

HOW INVERT WAS BUILT

The concrete invert was then formed in 6-ft. alternate blocks. 1:2½:4½ concrete was used. The crushed stone was obtained from a local limestone quarry, and was run of crusher, maximum size 1 in. Tests were made on both cement and aggregate. Concrete was mixed in batch mixers and deposited fairly dry, screened and tamped. A top coat ¾ in. thick, consisting of 1 part cement and 1½ parts sand, mixed fairly dry, was then placed on the concrete base and tamped and screeded into place. This coat was then given a metal trowel finish. The total thickness of the invert was 5 in. At every sixth block an expansion joint consisting of three thicknesses of tarred paper was made.

After the completion of a section of invert the 3-ft. side walls were placed. Panel forms 12 ft. long were used, held by bolts through the weep holes at the bottom and by cleating at the top. The forms were held in place by short 2 x 4-in. struts, cleated to the invert. The concrete in the side walls was also 1:2½:4½, mixed fairly wet, and spaded. The side walls were reinforced by ¼-in. square bars 8 ft. long, running down into the invert and spaced 2 ft. apart. Where the bank was surcharged, or where, for any reason, greater pressure was to be expected, the reinforcement was increased to ⅜-in. square bars spaced 6 in., center to center. At the 12-ft. section at the upper end of the work the earth slopes are sodded and seeded to protect them from erosion in time of storm.

The mixer was generally located at some point accessible for the delivering of materials. Runs placed on I-beams spanning the channel were used, and concrete was run both ways from the mixer. The wheelbarrow haul was frequently 500 ft. By placing flash boards on the weir discharging into Paxton Creek all water from the Paxton Creek watershed above the city was diverted to the river through the large conduit at the Wildwood flood control works.

Whenever there were heavy storms on the small Asylum Run watershed the works on Paxton Creek got the full benefit of them. Three or four storms occurred during each construction season, and the contractor, aside from the delay, was subjected to considerable expense and damage thereby. The violence of such storms may be judged from the fact that on one occasion a 4-in. pump was washed down stream along the invert a distance of 600 ft.

The contractor's plant consisted of two travelers with hoisting engines, two centrifugal pumps, two Pulsometers, two 20-hp. boilers mounted on wheels, several smaller stationary boilers, and from two to four one-bag mixers.

The contract was let under the unit item system, and the prices on some of the principal items were as follows: 1:2½:4½ concrete, $7.40 per cubic yard; earth excavation, 70 cents per cubic yard; earth embankment, 57½ cents per cubic yard; steel reinforcement, $90 per ton.

The prices bid on the minor items were generally sufficient to warrant the expectations of a fair profit, but the prices on the two principal items were not sufficient to warrant the expectations of a fair profit, when the nature of the work is considered, and it is believed that both the original contractor and the bonding company lost money.

The work was conducted under the direction of the Board of Public Works of Harrisburg, of which W. H. Lynch is superintendent and James H. Fuertes of New York City, consulting engineer.

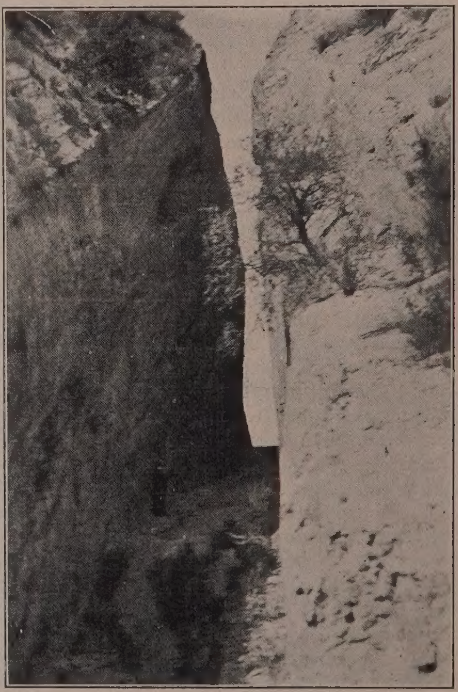
An Example of Costly Highway Construction

Route Near Los Angeles Finally Abandoned Because of 23-Per Cent Grade Even After Three Grade Reductions

BY WAY of contrast with modern economics of road building, it is interesting to note the extreme difficulties and dangers imposed upon traffic a generation or two ago for the sake of avoiding initial first cost in road construction. The accompanying illustration shows the road through Newhall or Fremont Pass, which was for many years one of the main lines of travel between Los Angeles and Bakersfield, Cal.

This route had been in use since General Fremont's time during the Mexican War. At that time, it is said to have been equipped with a windlass at the top for drawing the loads up the steep grade in the approaches to the summit. The grade at the Pass has since been subjected to three separate "reconstructions," each of which reduced the grade somewhat, but when finally abandoned a few years ago there was still a 23 per cent grade at the Pass with long approaches on either side of not less than 18 or 20 per cent. The cut at the Pass was made by the slow pick-and-shovel method, and is now 80 ft. deep. The sharp curves and steep grades were responsible for at least two fatal accidents in the last year of its service, and there was always great danger from rocks that rolled over the top and fell down into the deep cut.

This old route has been replaced by a broad, oiled-macadam pavement with a maximum gradient of 6 per cent. In surveying a new route through the Pass it was found that to keep within the limiting grade, any road over the summit would cost at least twice as much as a tunnel, and the route selected therefore involved a tunnel which is 435 ft. long, 20 ft. wide and 17 ft. high. It was built under the direction of A. E. Loder, chief engineer of the Los Angeles County Highway Commission.



AFTER THREE GRADE REDUCTIONS THIS CUT WAS 80 FEET DEEP AND THE GRADES STILL RAN AS HIGH AS 23 PER CENT

Automatic Device Controls Hypochlorite Application

Apparatus at Institutional Plant Proportions Accurately the Amount of Chemical to Varying Flow of Sewage

By E. E. LUDWICK
State Hospital, Warren, Pennsylvania

An ingenious device for the automatic measurement of the hypochlorite solution used as a disinfecting agent in the sewage treatment plant at the State Hospital for the Insane, Warren, Pa., has been constructed recently and is operating in a very satisfactory manner. The plant was constructed during 1912-13, and treats all the sewage of the hospital group of buildings having a resident population of approximately 1800. The works comprise a 6500-gal. Imhoff tank, intermittent siphon, sprinkling filter, chemical house and a final settling tank.

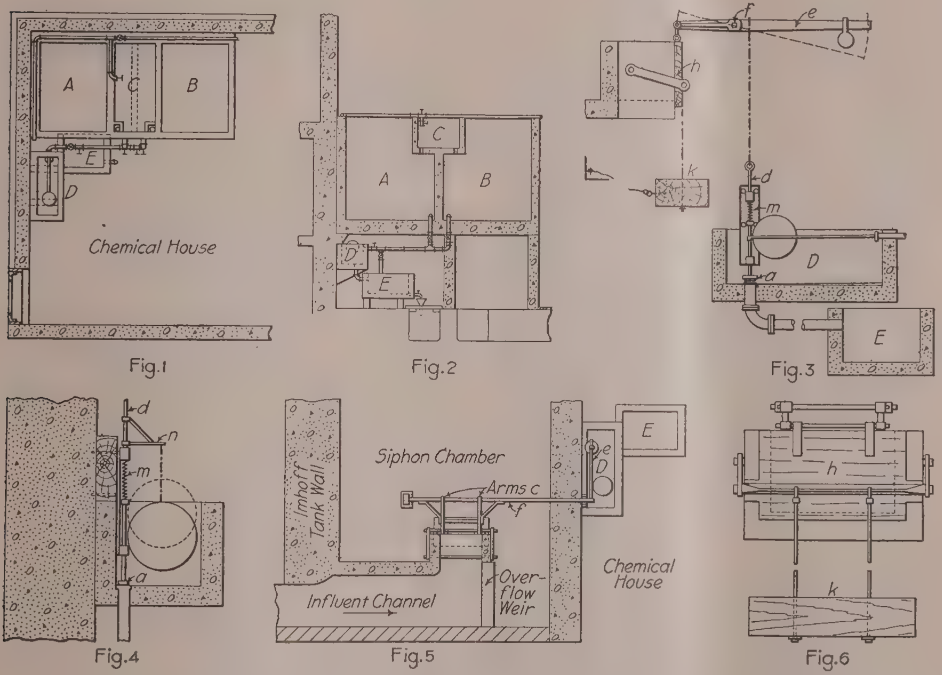


Fig.1 Fig.2 Fig.3 Fig.4 Fig.5 Fig.6

FIGS. 1-6—THIS APPARATUS PROPORTIONS CHEMICAL APPLICATION TO SEWAGE FLOW

Layout of Chemical House

The chemical house is provided with reinforced-concrete tanks, arranged as shown in Fig. 1. In the northeast corner, at a height of 3½ ft. above the floor, are two dilution tanks, *A* and *B*, with a capacity of approximately 660 gal. each, separated by a 4-in. division wall. A mixing trough, *C*, with a capacity of approximately 100 gal., is supported by this division wall (Fig. 2). A short distance in front of the dilution tanks, and at a height of 2 ft. above the floor, is a measuring box, *D*, with a capacity of 20 gal., and a little to the side of *D*, at a height of 6 in. above the floor, is a feed box, *E*, with a capacity of 22 gal.

The hypochlorite of lime is first dissolved in the mixing trough, *C*, and then allowed to enter the dilution tanks, *A* and *B*, through the outlets shown in Figs. 1 and 2. These outlets are merely holes through the bottom of the mixing trough, which are closed by wooden plugs while the lime is being dissolved. After being diluted to the proper strength the valves in the two 1¼-in. galvanized iron pipes which lead through the front of each tank are opened and the solution flows equally through each to a point where they combine into one 1¼-in. galvanized iron pipe terminating in the measuring box, *D*. Here a ball float valve (Fig. 3), is located, and, as the two valves mentioned above are left open, this valve controls the flow of the solution from the tanks according to the operation of the automatic device to which it is connected at this point. After flowing through the ball float valve into *D*, the solution is discharged into *E*, from which it enters the mixing channel and becomes thoroughly mixed with the effluent from the sprinkling-filter bed.

Automatic Measuring Device

The automatic measuring device, which is operated by the rise and fall of the sewage in the siphon chamber, and which proportions accurately the quantity of chloride solution with the varying flow of the sewage, is connected with the outlet and ball float control valve in *D* by the method illustrated in Fig. 3. The outlet in *D* is fitted with a brass ring seat, as shown at *a*, into and over which fits a brass cap connected to a brass rod *d*, 2 ft. in length. This rod, which is supported in such a manner as to allow a vertical movement, is connected by a chain to a lever *e* in the loft of the chemical house, which, in turn, is connected to one end of a revolving horizontal bar *f* extending through the concrete wall separating the chemical house from the siphon chamber (Figs. 3, 4 and 5). This bar is supported by a concrete pier in the siphon chamber and connected by arms *c* to a heavy wooden gate, *h* (Figs. 3 and 6), constructed and supported in such a manner as to give it an oblique movement up and down, when acted upon by the flow of sewage, thereby opening and closing respectively the end of the influent channel (Fig. 5) conveying the effluent from the Imhoff tank into the siphon chamber. It will be noticed that the arms *c* are on the opposite side of the horizontal bar *f* from that of the lever *e*, thus giving them an opposite movement when the bar is rotated. The remaining accessories necessary for the proper operation of this device are a heavy wooden float, *k*, connected to the wooden gate in the siphon chamber (Figs. 3 and 6), a spiral spring, *m*, so connected to the brass rod in *D* as to insure a downward movement (Fig. 4), and a horizontal arm *n* on this rod to which the arm of the ball float is attached by a chain.

Operating Details

The operation of this device is as follows: We will suppose that the siphon has just discharged the contents of the siphon chamber onto the sprinkling filter—the siphon chamber, therefore, is empty—and the large wooden float now supported by its connections to the wooden gate has, by its weight, pulled the gate down and against the end of the influent channel, thereby closing it. At the same time the lever in the loft of the chemical house has been elevated, thereby lifting the brass rod and cap in *D*, which opens the outlet at *a* and allows the contents of hypochlorite of lime solution to flow from *D* into *E*, from where it flows into the mixing channel, through which is now flowing the effluent from the sprinkling filter.

At this point of the operation the horizontal arm, *n*, attached to the rod in *D*, having been moved up with the upward movement of the rod, now lifts the ball float, by means of the chain connection, and closes the control valve *b*. As these relative positions are maintained until the rod moves down and closes the outlet in *D* it is seen that no lime solution can flow from the dilution tanks into *D* while its outlet is open.

Ball Float Regulation

The effluent from the Imhoff tank now entering the influent channel cannot flow into the siphon chamber on account of the wooden gate, which, as was stated before, is being held securely against the end of this channel by the weight of the wooden float. It therefore fills the channel until the level of the overflow weir (Fig. 5) is reached. This is merely one side of the channel constructed so as to be 3 in. less in height than the others. The effluent now overflows into the siphon chamber until in sufficient quantity to raise the wooden float, thus relieving the weight holding the gate in its closed position, and allowing it to be pushed obliquely upward (open) by the head of sewage behind it in the channel. The upward movement of the gate lowers the lever in the chemical house, and allows the rod in *D* to be forced down by the spiral spring, thereby closing the outlet at *a*. The ball float has also been allowed to fall, thus opening the control valve *b*, and allowing the solution to flow into *D* from the dilution tanks. The solution continues to flow into *D* until the surface of the same raises the ball float sufficiently to close the control valve, *b*, and then remains here until the siphon again discharges the contents of the siphon chamber, which releases it as before, the same operation being repeated as described.

Device Used to Measure Sewage in Place of Meter

In the absence of a meter on the force main from the pump house this device is now being used to ascertain the number of gallons of sewage pumped every twenty-four hours. This is accomplished in the following manner: The chloride of lime, after being thoroughly dissolved in *C*, is diluted in *A* and *B* so that in every gallon of solution there is contained 0.0004 gal. of available chlorine. The intention is to add

1½ parts of available chlorine to every million parts of sewage.

As is seen by the operation of the measuring device just described each time the siphon discharges the contents of the siphon chamber there is a certain fixed quantity of chloride of lime solution measured and discharged into the sewage. Therefore, as the quantity of sewage discharged by the siphon each time is known to be 1300 gal., in order to add the required amount of available chlorine the arm of the ball float in *D* has been adjusted so as to close the control valve *b* when 5.5 gal. of lime solution have flowed into *D*. Each morning, after the lime has been dissolved and diluted, an accurate measurement of the elevation of the surface of the solution in the dilution tanks is taken and noted, together with the time. On the following morning, at the same time, another measurement is taken, and the amount of solution which has flowed from the tanks in 24 hr. computed. This quantity divided by 5.5 will then give the number of times the siphon has discharged, which, multiplied by 1300, will give the number of gallons of sewage discharged or pumped to the plant in 24 hr.

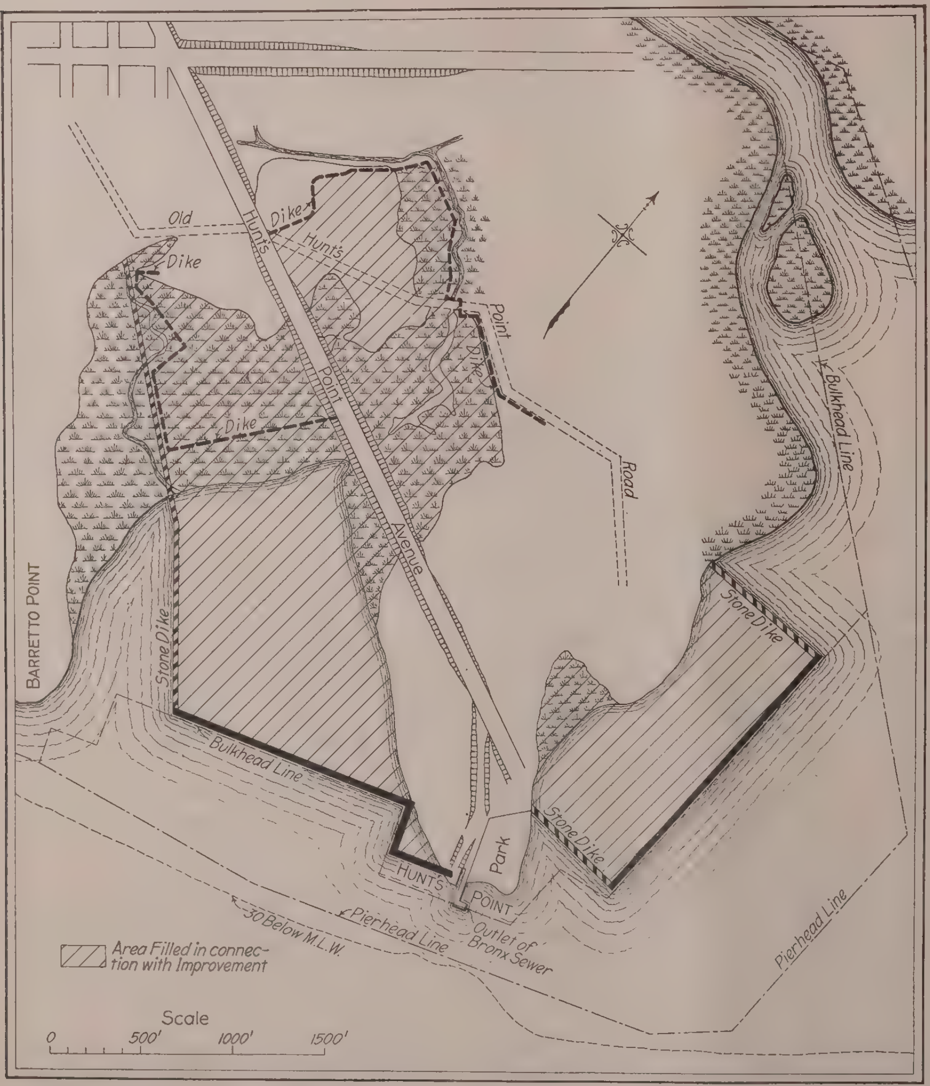
The plant and system entire was designed by C. F. Mebus of Albright & Mebus, consulting engineers of Philadelphia, and was constructed by P. L. Scholl & Company of Reading, Pa., under the supervision of the writer, who is now operating the plant for the hospital.

Hunt's Point Terminal in New York Involves Difficult Bulkhead Construction

Dredge Mud Out Before Building Pile and Riprap Bulkheads — Job Planned with Regard to Location of Preliminary Dredging and Backfill

CONSTRUCTING and filling behind 3600 ft. of bulkhead to reclaim 200 acres of ground and provide a water terminal which will later be connected to the New Haven, New York Central and Pennsylvania Railroads at Hunt's Point, Borough of the Bronx, New York City, involves heavy pile driving, deep dredging, the placing of nearly 400,000 tons of riprap, and the grading and filling of many million cubic yards of other material. A suction dredge has backfilled more than 1,000,000 cu. yd. of mud at the east bulkhead this spring, and 5000 cu. yd. of street sweeping and ashes are now being filled behind the same bulkhead each eight-hour day. A difficult feature of the work is capping and decking the bulkhead piles. The cut-off is at low tide, and work can only be prosecuted for a short while each day. The single driver employed can place seventy-five piles a shift, which is more than enough to keep ahead of the dock-building forces.

The general location and purpose of this development, together with some features of the design, were discussed in the Engineering Record of June 27, 1914, page 745, by J. R. Marsh, chief engineer of the Bronx Terminal Corporation. The development is being carried out for this corporation by the Jarrett-Chambers Company, Inc.



TEMPORARY DIKES USED AT FIRST TO CONFINE SOFT FILL TO PROPERTY

CONSTRUCTION PROBLEMS THOSE OF LAYOUT

As was stated in the article referred to, the line of both bulkheads lay over from 35 to 55 ft. of soft mud, bare in places at low tide, and covering very compact gravel or rock bottom. The effect of filling riprap among piles driven in mud of this kind is similar to that which could be had by exploding heavy charges of dynamite among the piles. It has been again demonstrated in the rockfills made from trestles on this job that the piles pull loose from any caps they are secured to, scatter in every direction and finish at any location or angle that might be least expected. It was necessary, therefore, to dredge off this mud blanket before building the bulkheads. The mud pumped had to be emptied in the swamps to be filled, but would not stay in place without temporary dikes to hold it. These dikes were built of blocks of turf and grass roots cut from the marsh land, and in places sacks filled with mud were used. They had to be located well behind the old shore line before a foundation could be found that would hold the pressure from the fill. This necessitated at times discharge lines from the dredge 4000 ft. long.

Dredging was begun on the east bulkhead site first, and the entire swamp area north of the Hunt's Point Road and part of that south of the road were filled in before the site of the first bulkhead had been cleaned. More than 500,000 cu. yd. of mud was disposed of by this operation. While piles for this bulkhead were being driven and capped, the dredge was transferred to the west bulkhead. The piles were delivered on scows, unloaded to catamarans made of logs with uprights spiked to them to keep the piles from sinking and floating off, and towed to the driver as wanted by a small gasoline tug. The riprap was placed behind the dock-building crew as it progressed on the north bulkhead.

FLANKING DIKES FILLED FROM BRONX SUBWAY CUT

Meanwhile trestles were built with an overhang land driver on the site of the stone fills which flank the north bulkhead. Stone brought by standard-gage dinkies from an adjoining contract on the east branch of the Bronx subway was used to make these fills. As will be noted from the accompanying layout plan, the property is cut at the actual end of Hunt's Point by a small park, in which is located the outfall of the Bronx sewer. The east bulkhead joins high ground just west of this park, but the other edge of the park was in water, necessitating a short stone fill at this point.

Stone from the subway was also largely used to riprap the east bulkhead. As soon as the east bulkhead was filled with stone it was backed with a blanket of street sweepings to retain the mud. The discharge of the dredge was then turned behind it, and the remainder of the mud dredged from the site of the south bulk-

MOVEMENT PRODUCED BY DUMPING STONE FILL IN SOFT MUD FROM THIS 2500-FOOT TRESTLE FINALLY TORE IT APART

head. More than 400,000 cu. yd. was placed in this location. The line of fill, made with rubbish and ashes, along the top of the stone dike for the north bulkhead, proved very hard to close, on account of the large tidal area still unfilled behind the dikes. A floodgate, to be of use, would have been of prohibitive size. The feat was finally accomplished after a week's hard work.

Problems Encountered on the West Bulkhead

Cleaning the mud off part of the west bulkhead site exposed the rock. Piles, of course, could not be put in here until some riprap had been placed through which to drive them. The first section of the rockfill is therefore being made in advance of the driver on the west end of this bulkhead with stone from the downtown subway cuts delivered on barges. A trestle 2500 ft. long was driven out to the west end of this bulkhead with a land driver. From this the stone fill for the flanking dike is being dumped. The fill is being made with stone from the Bronx subway cuts hauled by dinkies. As with the fill on the east end of the east bulkhead, this trestle quickly disappeared when dumping began. Attempts to maintain it were abandoned after the fill reached the surface, track being laid directly on the fill.

When the second bulkhead has been finished, the dredge will remove the mud from the pier slips out to the channel line, and dispose of it in the large bay south of the point.

Fill Consolidated with Street Sweepings

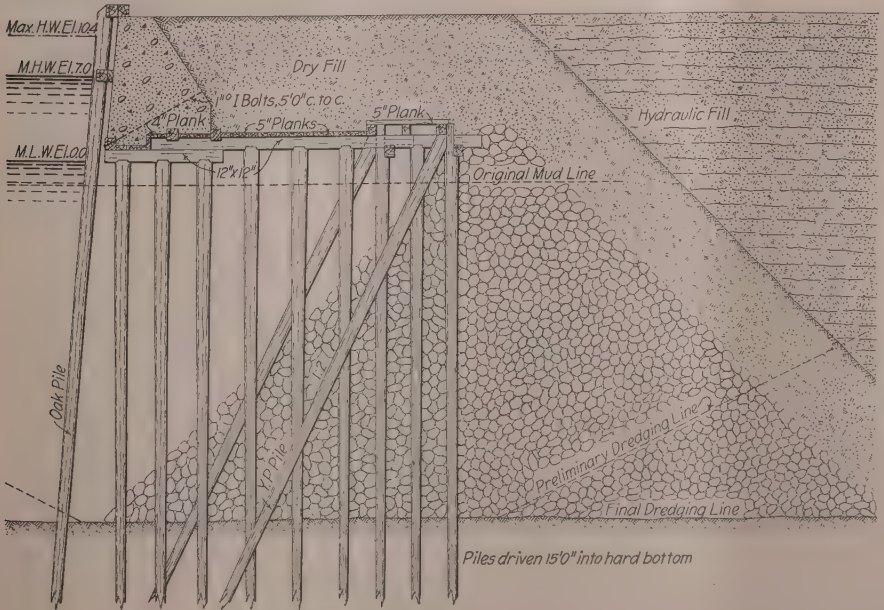
To make this mud fill solid, ashes and street sweepings are being used. It was problematical how much mud this material would take up, as the voids in a given yardage of it are an indeterminate quantity. About 700,000 cu. yd. of it was arranged for, to be used behind the north bulkhead, and 600,000 cu. yd. has already been placed this year. More will probably have to be used. Two 5-yd. orange-peel dredges, similar to floating dredges, but built on the bulkhead, are used to unload this material from scows into 10-yd. dump cars drawn by standard-gage dinkies. The dump tracks are carried on top of the fill as it progresses, for which purpose the fill has proved amply solid. This outfit is now placing street sweepings at the rate of 5000 yd. a day.

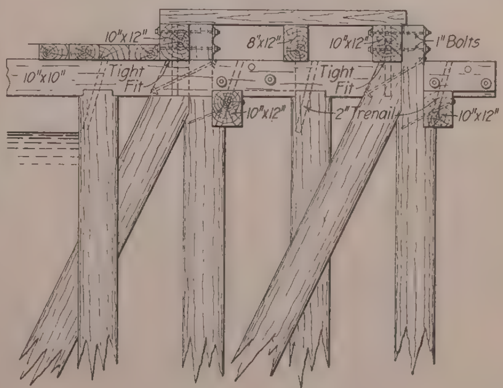
CLOSE JOINT AT TOP OF BATTER PILE

Bulkhead Work Done at Low Tide

Capping the piles and decking the bulkhead can only be worked at for a few hours each day. The rest of the time crews are kept busy framing timber. A large derrick boat, the derrick on the mixer boat, and a small derrick on the compressor barge are spotted where work is going on to handle caps, pile butts and plank, and to pull the piles into line. Wood-boring machines driven with compressed air are used. The joints between the batter piles and the straight piles and caps are of an especially stiff construction, and develop the full value of the batter piles. One is well shown in the accompanying illustrations.

None of the concrete wall has yet been placed. This work can be prosecuted very rapidly with a small crew and little overhead expense, and will be finished while the final filling is being done by the dredge. The barge on which the concrete plant is mounted was designed especially for the job. The mixer on this boat is mounted high enough to dump directly into the forms at low tide, and is fed through bins with a grab bucket.





PLANK LAID JUST BEFORE CONCRETING LEST ROUGH WATER TEAR THEM OFF—FRAMING DETAILS GIVE GREAT RIGIDITY

The job has been thoroughly planned, and a large chart, with straight lines showing the estimated progress of each class of work, is tacked on the wall of the superintendent's office. The actual progress is plotted on this chart each day, with the result that the expected progress has been lived up to or exceeded in every line of work.

The first contract on this work was completed by the Foundation Company under the direction of Ralph H. Chambers, then its chief engineer. The work is now being carried on under a second contract let March 26, to the Jarrett-Chambers Company, Inc. Edwin S. Jarrett, the other member of this firm, was formerly vice-president of the Foundation Company. Jefferson Davis, as superintendent, has had charge of the job since it was started.

LEFT — CHANNELS PROTECT TIMBERS WHILE RIPRAP IS DUMPED

RIGHT—RUBBISH ON SCOWS AT RIGHT WILL SOLIDIFY MUD FILL AT HUNT'S POINT TERMINAL

Mirrors Prevent Road Accidents

BY MEANS of a system of mirrors, Glencoe, Ill., has materially reduced accidents at one of its most dangerous street intersections, Green Bay Road and Hazel Avenue. Both the roads approach the street intersection on the down grade, and drivers of cars passing west through the viaduct on Hazel Avenue heretofore have been unable to tell whether a vehicle was approaching from either direction along the Green Bay Road. A large mirror eight ft. long and about six ft. in height has been placed at the southeast corner of the intersection at such an angle that the driver of a car approaching down the grade in Green Bay Road from the north can see a car coming west through the culvert, and give it the right of way. A smaller mirror has been placed on the side of the culvert at the northeast corner, by means of which the driver of a machine going west through the culvert can see a car approaching from the south in Green Bay Road. It is said that the mirrors are proving a success even at night, when the flare of the headlights is reflected in both directions.

Hydroelectric Plants in California now in operation have a total generating capacity of 436,043 kw., according to the president of the California Railroad Commission, and last year the steam and hydroelectric plants of California combined developed more than 2,000,000,000 kw.-hr. There are twenty-five power companies in California operating seventy-nine hydroelectric plants which transmit energy through about 7500 miles of transmission lines and 18,000 miles of distribution lines.

Radical Changes in Rail Sections, Composition and Manufacture Urged

Gustav Lindenthal Condemns Present Standards—Favors Experimenting with Double-Webbed Rails—Other Engineers Discuss Subject

THE RAIL PROBLEM—how to get a rail that will carry the heaviest railroad load safely and be immune from the danger of suddenly breaking—is as yet unsolved. In his presidential address to the American Society for Testing Materials, abstracted in the Engineering Record of July 3, page 8, A. W. Gibbs, chief mechanical engineer of the Pennsylvania Railroad, pointed out the disappointing progress with the problem, and urged certain reforms. At the May meeting of the New York Railroad Club Gustav Lindenthal, consulting engineer, of New York City, made a more sweeping arraignment of present standards and practices, and proposed radical changes, the most marked being a double-webbed U-shaped section. As Mr. Lindenthal summarized his remarks he advocates:

1. Heavier rail sections for the present heavier wheel loads.
2. In the fabrication, holding metal in ladle at least ten minutes for self-cleansing.
3. Pouring ingots large end up with a sinkhead.
4. Rolling rails from reheated cold blooms.
5. Reducing speed of rolls in the last few passes to, say, 4 ft. per second.
6. Having finishing temperature below 750 deg.
7. Experimenting with double-webbed rail for the heavy sections with the probability of finer grain and longer wear in addition to greater strength and safety of the rail.

A number of other engineers, including Dr. P. H. Dudley of the New York Central, W. C. Cushing of the Pennsylvania Lines, G. J. Ray of the Lackawanna and J. O. Osgood of the Central of New Jersey, discussed various phases of the subject. Some of their views were decidedly at variance with those of Mr. Lindenthal. Mr. Ray cited experiences on his road that had made him distrust the heavier sections. Little was said of the double-webbed rail, and those who mentioned it at all seemed to think that a radical departure from the present T-rail would not be desirable. There was, however, general concurrence with other views expressed by Mr. Lindenthal, and others agreed with him that the situation was far from satisfactory.

An abstract of Mr. Lindenthal's paper follows:

Importance of Rail Problem

No other known structure or member made of steel is exposed to such destructive stresses of every kind as rails. It can hardly be gainsaid that although the mechanical improvements in the manufacture of rail-steel have been brought to a high pitch of perfection, the metallurgical methods are not as good as they should or can be to dispel that feeling of insecurity which, rightly or wrongly, will persist until a decided improvement has been made. We have mills that turn out 4000 tons of rails in twenty-four hours with no more manual labor than was needed for 400 tons some years ago, but has the quality of the product been improved? Many fractures, split heads and other mishaps would not occur if the rails were strong enough for the rough work they have to stand. Rails are but bridges whose safety should be as much beyond question as that of the largest structure; but as long as rails of ordinarily sound steel break in ordinary wear and tear, as they do now, they are not strong enough.

Sound Ingots First

The first requisite of good rails is good steel and we must insist upon sound ingots to begin with. There is no difference of opinion of what is a sound ingot, but there are great differences of opinion on the method of getting it. Metallurgists favoring the present practice of pouring ingots with the small end up and without a sinkhead have really nothing to commend it for except cheapness of production. This is such a well-established practice, however, that it will not be changed without compulsion and extra compensation. The time has arrived when the rail consumers themselves must take the lead in determining certain details in manufacture which will insure thoroughly sound steel, but they must also expect to pay, at least for a time, a higher price.

Not one of the present specifications for steel rails insures thoroughly sound ingots. The external defects of flaws and seams are more readily discovered by inspection and tests than the insidious internal defects caused by unsound metal. The latter are, in fact, discovered only by chance, notwithstanding the closest inspection, and the only way to prevent them is to insist on methods of manufacture that will absolutely avoid them.

Unbalanced rail sections, meaning those with thick heads and thin webs and flanges, should be given up. Really good and tough rails cannot be made that way. Neither can good rails be made by rolling them in the fewest number of passes and finishing at a high heat. But this is the only way the present form of heavy rails with thin flanges which get cold in the rolling while the thick heads are still waxy can be finished without breaking the rolls.

Experience indicates that the bulk of heavy steel rails in this country will hereafter be made of basic open-hearth carbon steel with carbon between 0.75 and 1 per cent, provided that phosphorus and sulphur are both kept low. The expensive alloy steels, like manganese, nickel or vanadium steel, will hardly be used for steel rails except for special purposes and in small quantities.

DEFECTS OF FABRICATION

Ordinarily the manufacturing difficulties are not in the melting furnace. The defects of fabrication as regards soundness occur mostly after the metal, having been brought to the proper composition, is teemed into the ingot molds. Thereafter the defects in steel arise mainly from five causes—blowholes, piping, segregation, inclosure of slag and oxides, and other foreign matters. The first four causes occur in the ingot, the fifth in the roll.

Small blowholes are not harmful and are readily welded up in rolling, and larger blowholes can be avoided by the addition of aluminum. All oxides, sulphides and other chemical impurities will, if given sufficient time, float up into the slag on top. This self-cleansing process by holding the metal in the empty ladle before teeming is very important, and an interval of at least ten minutes should be allowed for that purpose. In the present practice the metal is teemed as a rule from the ladle into the ingot forms as quickly as it can be conveyed after the addition of the ferromanganese, and there is not allowed sufficient time for the cleansing of the steel bath from impurities before teeming.

While the addition of aluminum reduces blowholes, it increases piping; and piping facilitates segregation. In all real specifications piping and segregation are treated as unavoidable evils, and the only provision against their mischievous effect is the requirement for discard from the upper part of the ingot. As the extended pipe varies with each ingot and may reach all the way from 15 to 80 per cent down into it, the amount of discard would need in fact to be determined for each individual ingot. This is not practicable, and the amount is therefore assumed at some convenient percentage, which the rail maker wants to have as small as possible. To this "hit or miss method" must be ascribed the largest share of blame for unsound steel rails. Even a discard of 30 per cent is no real protection.

CAST INGOTS BIG END UP

The fundamental requisite for obtaining solid ingots is the maintenance of a fluid top and sinkhead for filling up automatically and quickly any cavities formed in the ingot by shrinkage during cooling. Stated more correctly, cavities must not be allowed to form at all, because immediately segregation takes place which cannot be cured thereafter by filling the frozen cavity with fluid metal. If the ingots were cast with the big end up, and the top of the steel kept fluid so that it should be the last to solidify, no deep pipe would form and no segregation would occur in the interior of the ingots. There are a number of well-known methods to this end, but all of them cause extra cost and labor and will therefore not be used unless made specifically a part of the contract and paid for.

In the present practice pipes and segregation, being at the smaller end of the ingot, pass into the rolls first and are closed up and squeezed into the metal and lengthened in the rolling to an unknown extent, forming interior seams and defects which cannot be discovered by inspection. This inferior method of rolling should be prohibited by the specification. Cropping may and may not remove pipe. Only successive croppings and a microscopic examination of the cropped ends would lead to the discovery of the interior defects, and that is impossible with the thousands of rails rolled in a mill in a day. Any method of forming ingots which will produce pipe and give precarious results is wrong and dangerous.

BAD PRACTICES IN ROLLING

Sound ingots, free from blowholes, pipes, segregation and internal impurities are, however, only the preliminaries for the rolling of good rails. Wearing quality, great resistance to abrasion, and great strength and toughness are necessary, and these qualities depend not only on the chemical composition of the steel, but also on the fineness of grain, which is developed in the process of rolling. In practice the number of passes are made as few as possible so as to have for the rolling train the largest possible output. That does not put the kind of work on the plastic steel that will break up the coarse crystals which form during the higher heat. There is also considerable doubt as to whether the continuous process does not produce a sleazy metal unsuited to the formation of fine-grained texture.

All existing specifications permit the rails to be finished at too high a heat, which is evidenced by the high shrinkage allowance at the saws—from 5½ to 7⅜ in. prescribed for 33-ft. rail when it should be 4 in. This contributes to, but is not the sole cause of, coarse crystalline structures in the rail head, just where a fine grain is most wanted. For the high finishing heat the rail makers have a good excuse in the thin webs and flanges of the heavy rail sections. The flanges would otherwise cool down too quickly and get dark in the rolling while the head was still at a bright heat. Therefore, reform must begin with the rail section. Web and flanges must be thicker and head if possible thinner, so that the metal may keep a more even heat during rolling and cool more uniformly after rolling, avoiding large internal stresses. In a well-balanced rail section it is easier to break up the coarse crystals of the higher heat than permit the finer crystalline structure to be produced by the work of rolling at the lower heat, and finish the rail near the point of recalescence (675 deg. C.).

More time should be given to the last five or six passes of the rail through the rolls. At the high speeds used, 10 ft. per second, the pressure from the rolls may be sufficient to penetrate through thin metal, as in the web or face of rail, but it does not seem to be sufficient for the penetration through the 2½ in. of metal in the head. It will produce in the head a fine grain only near the surface if at all, leaving the interior coarse-grained and weak. As an experiment the speed for these last passes should not exceed 4 ft.

For the further control of quality of steel the minimum number of grains or pearlite cells per square inch of rail section should guide. This is fully as important as any tensional or bending test, or as the drop test. The aim should be a minimum of 70,000 pearlite cells per square inch, nearly uniform over the whole section.

TESTS INADEQUATE

The drop test as ordinarily prescribed in rail specifications is crude and not sufficient for judging the quality of the steel. Additional acceptance tests are necessary. Drop tests on different rail sections could be compared only when the velocity of the tup is the same for all and when the weight of tup varies with the section modulus of the rail section. This condition is not fulfilled in present practice. The value of the test for comparative purposes is further impaired by the uncertainty as to the amount of force which is absorbed by the mass of the drop-testing machine, which amount varies with each rail section, and by the further fact that proportionality of fiber stress exists only up to the elastic limit of the metal, and not beyond it. The permanent deflection caused by the falling tup is, therefore, not computable, and by itself is not a criterion for the strength or quality of the steel. Therefore rail specifications of recent years prescribe certain tensional elongations of extreme fibers during the drop test. But these are not as reliable as tensional tests with specimens cut from rail, if they could only be made more expeditiously.

Bending tests are important for disclosing fissures caused by slag elongated in the rolling, but most important of all is the microscopic test for the determination of the fineness of grain and freedom from slag.

From a practical point of view the inspection of rails should particularly concern itself with the following features:

1. At the furnace and ladle, seeing that the proper method and time (minimum 10 min.) is given for the self-cleansing of the metal.
2. At the ingots, that the larger end is up and is provided with a sinkhead.
3. At the reheating furnace, that ingots are not exposed to an oxidizing flame and come out thoroughly heated at a uniform temperature.
4. At the rolling train, that the finishing temperature shall be below 700 deg. C., indicated by a dark red cherry color.

STRESSES IN RAILS

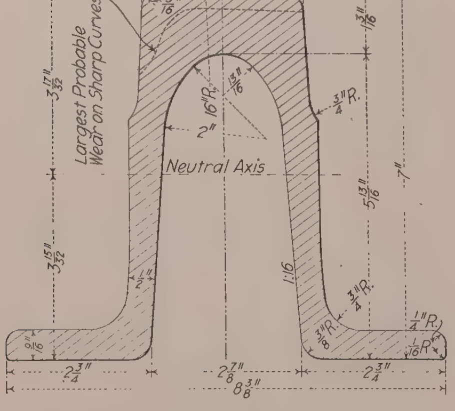
The largest stresses in rails are produced by driving wheels of steam locomotives at high speed; the largest wear of rail is caused by heavy freight trains. The largest wheel loads twenty-five years ago were 15,000 lb., and American rails then weighed from 75 to 80 lb. per yard. Since then wheel loads on passenger engines have reached 34,000 lb., an increase of 125 per cent, and speed, which greatly intensifies the impact stresses, has also largely increased. The weight and strength of rail have not, however, increased correspondingly. The stiffness of a rail is measured by the moment of inertia of its section and the strength by its section modulus, and each increases faster in proportion than the weight of rail, so that a 100-lb. rail, although only 25 per cent heavier than an 80-lb., is about 65 per cent stiffer and 50 per cent stronger in bending strength. But this is not enough for the 125-per cent increase of wheel loads and for the increased speed.

The bending, shearing and other stresses to which a rail is subject cannot be accurately ascertained for dynamic effect of loads at high speed. Much has been written on the subject, but real proof of actual stresses is wanting. Experience is an indispensable guide for determining the size of rail. If a rail is found to be not strong enough for any given condition it should be replaced with one stronger.

LARGER SECTIONS SHOULD BE USED

The 70 or 80-lb. rail (section modulus 10) was found to be strong enough for the wheel load of 15,000 lb. twenty years ago; for the 100-lb. rail (section modulus 15), the wheel load should be limited to 22,500 lb. but for the fact that the steel in this section is not of as good quality; because of this fact the load should not exceed 20,000 lb. For wheel loads of from 30,000 to 34,000 lb. a modulus of from 20 to 22 should be used,, which would correspond with the 135-lb. rail now in use on the Central Railroad of New Jersey—but that rail, the heaviest in the United States, is not a well proportioned section. The new 125-lb. section now experimentally used on the Pennsylvania Railroad has the same strength and stiffness and saves 10 lb. per yard as the result of a better distribution of metal. The head is lighter, the base narrower, and the metal more evenly distributed, insuring better rolling properties.

The carbon is 0.85 per cent desired, as against 0.70 per cent desired for the 100-lb. rail. The aim is to get for the heavier section a harder rail with longer wearing capacity sustaining a greater wheel tonnage.



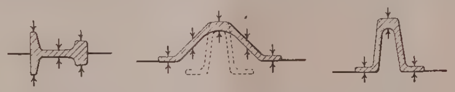
DOUBLE-WEBBED RAIL PROPOSED

Area of section, 13.4; moment of inertia, 78.1; section modulus, head, 22.1; section modulus, base, 22.5

Going a step further toward obtaining a fine-grained durable rail of heavy section, there are reasons for doubt whether any amount of care in the rolling of heavier T-rails will produce in the head, where it is most desired, a fine grain, toughness and a high elastic limit uniform throughout. Experienced rollers contend that the form of a T-rail precludes good results on the large head of the heavier sections. The rolling pressure on the rail is sidewise, at right angles to the action of the section and the direction of the wheel pressure, whereas the heaviest pressure during rolling should be at right angles to the top to produce a fine grain in the fixed head. The metal in the head is compressed in the most unfavorable direction, that is, crosswise to the stresses it will have to bear.

U-SHAPED RAIL

Hence a modified and enlarged form of the old inverted U-shaped or double-webbed section might answer better the purpose of a heavy rail than the T-shape. In the double-webbed rail the steel receives pressure from the first half to the last vertically upon the head, producing the desired dense fine grain throughout its thickness. The metal can be first rolled flat then bent back to the form shown in the accompanying sketch, and in the last few passes the rail receives its final form. The very method of its rolling should insure the denseness and toughness of the steel.



HOW THE PRESSURES COME IN ROLLING T-SHAPED AND U-SHAPED SECTIONS

An experiment with a few miles of track laid with the double-webbed rail will show results in a year. There is no difficulty in making a splice as strong for the double-webbed rail as for the T-rail. For switches and frogs it need not be used. The T-rail can readily be connected to the double-webbed rail by a special rail joint.

Mr. Lindenthal then concluded his address with the summary given at the beginning of this article.

Discussion

In the discussion that followed Mr. Osgood of the Central of New Jersey spoke of the 135-lb. rail in use on his road. He pointed out that it was adopted experimentally in 1909, for use on sharp curves (running up to 13 deg. 30 min.) under heavy traffic in Pennsylvania, and that while it was conceded to be less strong than could be made at that weight, it had proved very satisfactory for the special purpose for which it was intended. At the end of 1914 the company had laid 9151 such rails, and of the 124 that have failed none of them were among the 1358 laid in 1914, and only nine were in the 4174 laid in 1913.

Mr. Osgood did not regard with favor the change to the double-webbed section. He was impressed with the difficulties to be met at frogs and switches, at joints, especially insulated joints, and in handling the rail, and believed that much more could be accomplished by improving the quality and uniformity of the steel than by any material change in section.

Dr. Dudley gave an extended discussion of the subject, disagreeing with a number of Mr. Lindenthal's points, and taking up many phases of the subject not gone into by Mr. Lindenthal. Mr. Cushing agreed with Mr. Lindenthal as to the importance of securing sound ingots, and also as to the need for methods that would prevent defects, such as seams, rather than attempt to remedy them. Neither he nor Dr. Dudley commented on the double-webbed rail.

MR. RAY HAS FOUND LIGHT SECTIONS MOST DEPENDABLE

Mr. Ray's discussion is abstracted as follows:

In general I agree with Mr. Lindenthal that the railroads, in many cases, have not increased the weight of rail to correspond to the increased weight of rolling stock. I believe, however, that one very good reason for this slowness is that the heavier rail has not been of as good quality, nor has it worn as long, as the lighter rail. On our Morristown line we have a considerable tonnage of 80-lb. rail, all of which has been in service thirteen years or more; some of it as long as twenty years. Pacific-type passenger engines, with axle loads of 62,000 lb., pass over this rail continually, and yet it does not cause and never has caused any trouble from breakage. The 91-lb. rail, from two to four years old, in the same service, does break continually.

Unfortunately the railroads have had to experiment with rail an unreasonable amount in order to determine for themselves the best available quality. The Lackawanna has bought premium rail from several different steel mills (on the latters' recommendation) during the past eight years. The cost of this rail has ranged from the standard price up to more than $80 per ton. The experimenting has all been done with a view of discovering some kind of rail which would wear well and at the same time be safe from a breakage standpoint. But few of these purchases have been at all successful—more have been complete failures.

DOUBTS DESIRABILITY OF HIGH CARBON

I do not believe that open-hearth rail, with carbon from 0.85 to 1 per cent, will come into general use, even with the heavier section of rail. I believe that rolled manganese rail of a much lighter section will prove more economical. We have a considerable tonnage of this rail, 101 lb. per yard, laid on sharp curves on a 1½-per cent descending grade, where from six months to a year is the maximum life of the best open-hearth rail. This manganese rail has now been in service 2½ years and looks as if it will last much longer, and with it we have not had a single rail failure.

When we increased our 91-lb. section to 101 lb., we had rolled a considerable tonnage with carbon up to 0.80 per cent. Two special allotments we had rolled with a minimum of 0.80 per cent and a maximum of 1 per cent. These rails were laid on the sharp curves above referred to, but before they had been in the tracks six months they were breaking so frequently that we had to remove them.

Prior to 1906 we seldom had a broken rail. Most of the rail on the main line was 80 lb. and our maximum axle load had been approximately 45,000 lb. for six years. The 90-lb. Bessemer rail, rolled between 1904 and 1908, showed a marked tendency to split heads, split webs and battered joints. Again this rail wore out so fast on sharp curves that it had to be changed out continually. In 1904 and 1905 100-lb. Bessemer was tried but it wore faster and gave no better, if as good, service as the 90-lb. rail. The maximum axle loads on fast engines increased in 1908 to approximately 56,000 lb. and at that time we started to use open-hearth rail. In 1908, 1909 and 1910 many thousands of tons of high-carbon open-hearth rail were purchased. Since that time we have been removing bad heats, and finally the entire rollings of 1908 and 1909 from the track. Our experience shows that the failures in high-carbon open-hearth rail are progressive, that is, they increase at a marked rate as the rail continues in service. It is true that we have had less breakage with the 101-lb. sections, but the same progression of failures is evidenced where the carbon is excessively high. In 1913 our maximum loads were again increased to approximately 62,000 lb., but strange as it may seem, the old Bessemer 80-lb. rail never did cause much trouble from breakage, even under the heavier wheel loads.

I am much more afraid of brittle rail than piped rail. A piped rail does not break in the drop test any more easily than one not piped, and I believe I am correct in stating that piped rail have caused few accidents compared with other forms of rail failures. A pipe as a rule shows up and is easily noticed by maintenance forces. Transverse fissures can seldom be found before complete failure. It might be interesting to state that we have never discovered a transverse fissure in any of the old 80-lb. Bessemer rail, while we have found them in both the 91-lb. and the 101-lb. sections from at least two different steel mills.

A Vicious Circle

I do not believe we can find justification for increasing the standard rail section to 125 lb. or heavier per yard on the ground that the increased cost will be made up from the saving in operating expenses with the heavier locomotives and bigger cars, nor do I believe that a considerable part of this expense can be saved by means of less maintenance force required. The stiffer rail section will reduce the amount of surfacing, but the cost of laying the rail will be materially increased; tieplates, track bolts and joints will cost more to purchase and handle. All frogs and switches will cost from 50 to 75 per cent more, and it will require a derrick to handle the frogs or even to change out a rail, when one has to be removed. Every part of the rail and rail fastenings will cost more money, and when main-track rail is relaid in side track or yards there will be a corresponding increase in the cost.

If such heavy rail were universally adopted, not one-quarter of the main track would be so equipped until the motive power department would want to increase materially the wheel loads of both engines and cars, and they would soon overload the new section. We would have to rebuild our bridges, widen our track centers and side clearances, and in fact spend all that could be saved in operating the big engines and cars in rebuilding the road and maintaining the equipment and tracks. I do not wish to convey the idea that a heavy rail should not now be used where the wheel loading is excessive, but I do contend that 125-lb. rail, or even a heavier section, will not eliminate all of our rail troubles, or even breakages.

Conclusions

In concluding I should like to sum up as follows:

1. I agree that as a general proposition a heavier rail section than is generally used is desirable where the wheel loads are extra heavy and the speed high.

2. Care should be exercised that excessively high carbon (above 8500 per cent) should not be permitted, even in the heavy rail, otherwise it will be apt to break as the rail becomes old in service.

3. It is very desirable to eliminate all pipes in rail, but other defects in chemical composition or rolling are more serious, and it is more desirable to test the finished rail from each ingot to detect segregation and brittle rail than for the elimination of piped rail.

4. The double-webbed rail, recommended for trial by Mr. Lindenthal, would be very expensive; a good splice bar would be very hard to get, and all special work, such as frogs and switches, would have to be made out of T-rail, as at present.

5. The present 2-in. limit of allowable flat stops on freight car wheels should be diminished.

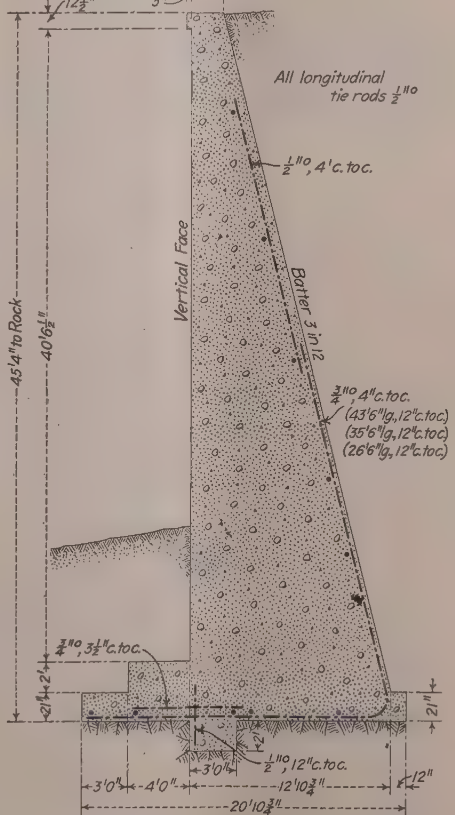
6. The increased cost of a 125-lb. or heavier rail section can only be justified by the safety consideration in handling the present heavy wheel loads, and not from an economic standpoint.

Unusually High Retaining Walls of Cantilever Type

Viaduct in St. Louis Contains Approach Fills Retained by Vertical-Faced Reinforced-Concrete Walls as High as 45 Feet

By S. W. BOWEN
Principal Assistant Engineer, with Brenneke & Fay,
Consulting Engineers, St. Louis

SOME TIME AGO there was constructed in St. Louis a reinforced-concrete viaduct having approaches with retaining walls of unusual height. The structure was built by the St. Louis Terminal Railway Company; it carries Union Avenue over the right-of-way of the Terminal Belt Line, and has a total length of 1190 ft. The main crossing over the right-of-way is only 100 ft. in length, and consists of three spans. The long approaches are built of earth fill inclosed by retaining walls of the semi-gravity type, 80 ft. apart, to provide for a 60-ft. roadway and two 10-ft. sidewalks. For a considerable part of the length the retaining walls are unusually high, reaching about 45 ft. at the highest point. In order to avoid encroaching on the narrow roadways along each side of the viaduct the walls were designed with vertical front faces, putting all the batter in the back face. This necessitated a considerable projection of the footing course.



SECTION OF RETAINING WALL AT HIGHEST POINT OF APPROACH FILLS

A cross-section of the wall at the highest point is shown in the accompanying sketch giving full details of the reinforcement. Rankine's theory of earth pressure was used in the design, and a superimposed load of 100 lb. per square foot on the fill was assumed to allow for live load. This live-load factor is only a small part of the whole load for walls of this height, amounting in this case to about 2 per cent.

Estimates for Economical Batter

Because of the height of the walls an investigation was made to determine the most economical batter for the rear face. The thickness at the top was made 2 ft. in all cases, and several alternate designs were compared, using batters ranging from 2 in 12 to 3½ in 12. Estimates were made of the cost per linear foot of wall for each of the sections, including costs of concrete, steel, forms, excavation and earth fill. The cost per cubic foot of concrete was assumed to be a maximum for a ½-in. batter, due to the increased difficulty of placing in a comparatively narrow space and to the richer mix which would be necessary. The cost of the concrete was assumed to be a minimum for the 3½-in. batter, and between these limits the cost per cubic foot was assumed to vary uniformly.

It was found that the estimated cost per foot of wall did not change as much as might be expected, and the above refinements were necessary in order to determine the minimum cost. The batters and corresponding cost per linear foot of wall were plotted and an average curve was drawn, from which it was found that for the assumed conditions the economical batter was about 2¾ in 12. A 3 in 12 batter was then used in order to simplify the drawings.

A 1:2½:5 mix was used, with washed gravel for the coarse aggregate, and the reinforcement consisted of high-carbon steel deformed bars for which a unit stress of 20,000 lb. per square inch was permitted.

The viaduct was designed by Brenneke & Fay, consulting engineers, St. Louis, and built by Fruin & Colnon, contractors, also of St. Louis, at a total cost of $140,000, including paving, lighting and engineering.

TAMPERING WITH CANAL LOCKS, gates, buoys, bridges, dams or other structures by any person without authority is made a felony in New York State by a law passed by the last Legislature. In addition to petty thefts of State property along canals, local officials have frequently reported meddling with the locks, resulting in overflowing of the banks and injury to private property.

Steel Shields Protect Traffic During Removal of New York Subway Roof

Street Surface at Times Square Raised, Existing Structure Cut Into and Old Steel Replaced for Operation of New Seventh Avenue Subway

CONSTRUCTION at Times Square of Section 6-A, Routes 4 and 38, of New York City's new subway system involved the unusual work of raising the street surface temporarily about 2 ft., cutting out the roof of the existing subway without endangering its heavy traffic, and replacing the present roof of beams and the supporting columns with new steel so designed as to provide for the new track layout, and at the same time not interfere with train operation over the present tracks. This steel was handled under the street and over the existing subway roof with scant clearance.

Special steel shields, sliding on bolts previously hung through the concrete of the old subway roof, protected the tracks from falling pieces of concrete while the roof was being removed. As the roof panels were cut out, thin reinforced-concrete slabs laid on the lower flanges of the old roof beams kept the tracks inclosed and later served as forms for the new concrete roof.

Location of the Work

The present subway turns from Broadway into Seventh Avenue at Forty-fifth Street, and just south of Forty-third Street begins its swing under the Times Building into Forty-second Street. The new Seventh Avenue subway will leave the present subway on the west side of this curve, and when it is completed will carry all the Broadway trains down Seventh Avenue on a tangent from the Forty-fifth Street curve. A crossover connection with the existing northbound tracks from Forty-second Street will be used only for emergency operation. The columns and walls to be removed in making the new connection are shown on the accompanying drawing.

After considerable discussion between the contractor and the engineers of the Public Service Commission, a modification of the method of construction contemplated in the contract was agreed upon which involved the placing of the new steel bents midway between the old. This method had many advantages, in that either the old or new roof members always offered a substantial framework over the moving trains, from which framework the temporary street surface could be posted, and on which materials of construction could be moved about and a shield or screen maintained to keep objects from falling on the tracks. It also tended to decrease the amount of work to be done on the tracks.

It had been recognized that this contract might involve difficulties and delays, and as it was not the determining factor in point of time for the opening of the Seventh Avenue route, thirty-three months were allowed for its completion. Due to the plan of work adopted, the organization of the contractor and the co-operation of the designing and field engineers of the Public Service Commission, ten months after its beginning the work was nearly completed.

NEW ROOF BEAMS SET, I-BEAMS UNDER STREET POSTED TO OLD ROOF BEAMS

Plan of Work Involved Raising Street

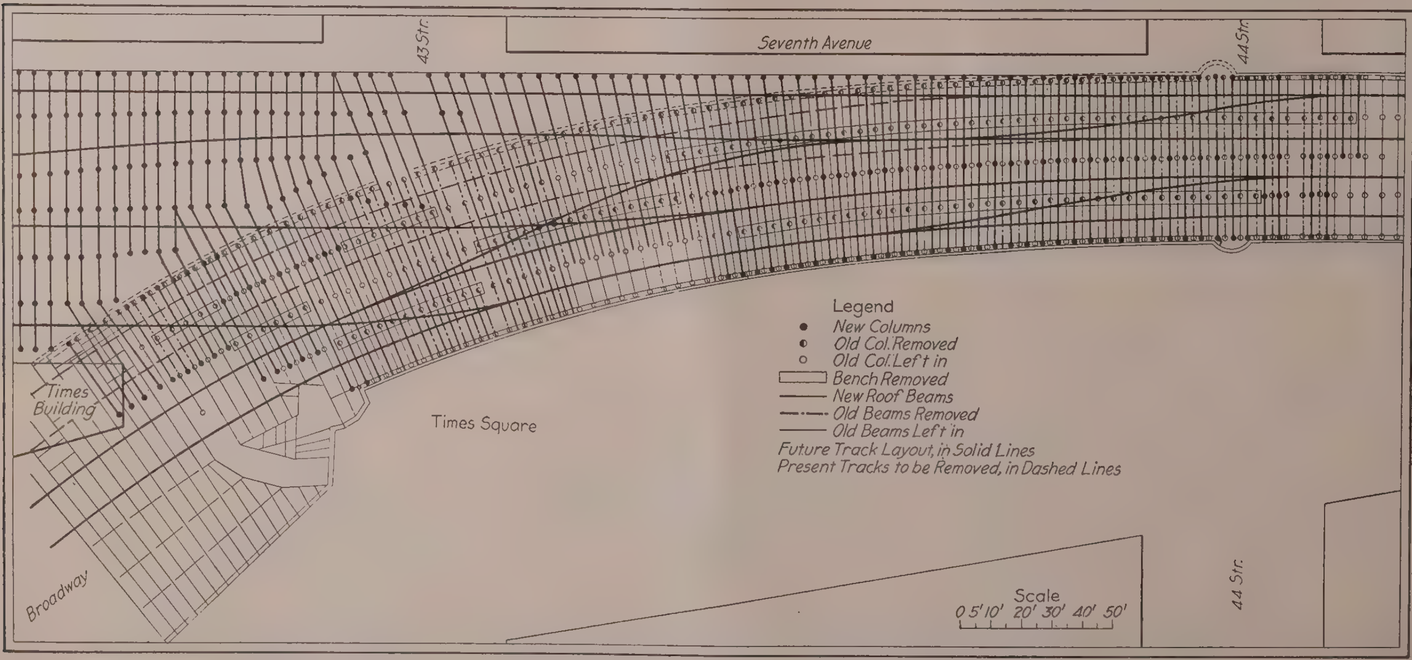
The first step taken was to raise the west sidewalk of Seventh Avenue about 2 ft. Next, the Seventh Avenue street-car tracks were raised, and then the street decking was placed on a level with them. This work necessitated turning northbound and southbound Seventh Avenue traffic into Broadway between Forty-third and Forty-fourth Streets for a few days, but crosstown traffic was maintained by means of ramps.

The decking consisted of an under course of 4-in. planks topped by 2-in. hardwood laid diagonally, and supported on 10-in. steel I-beams parallel with the street. These I-beams, in turn, rested on 12 x 12-in. timbers, which were posted down to the roof beams of the present subway.

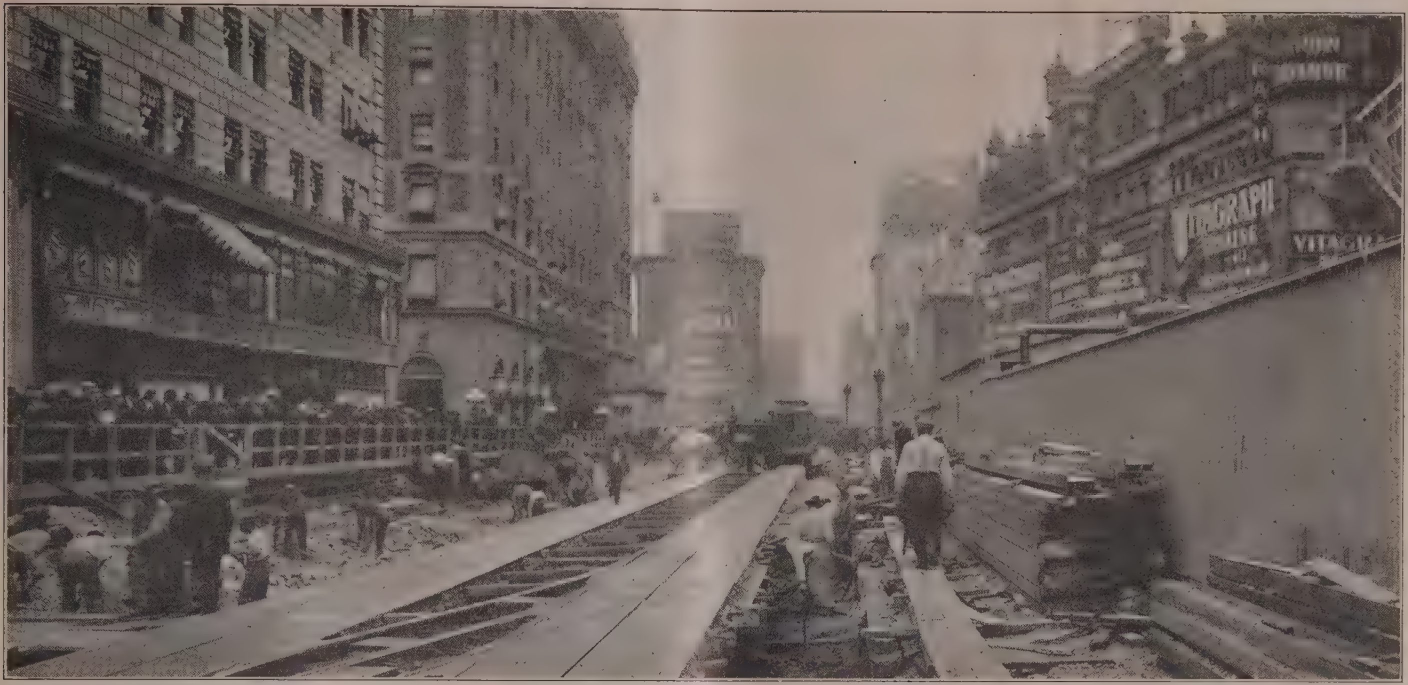
The temporary raising of the street surface raised the yokes under the surface-car tracks, which had rested on the old subway roof, sufficiently to allow steel to be handled under them. The decking proved practically watertight in several severe storms and was very stiff and effective in supporting heavy traffic loads. The danger of flooding the old subway at this point was great, as the existing sewers are inadequate to carry the maximum rainfall.

While this work was being done above the old subway the short connecting section to the west under Seventh Avenue was decked over and excavated. This excavation was almost entirely in rock.

The street surface having been temporarily raised, cutting out of the old roof was begun from the west side. Several alternate roof arches were first cut out. The 5 x 12-ft. plate-steel shields used for this had two pairs of 2-in. Z-bars on the upper side, riveted facing each other, with a 1-in. slot between. T-head bolts, supported from beams composed of two channels back to back, resting on the old roof beams, were dropped through holes drilled in the concrete roof arch, inserted in these slots, and turned and wedged up with keys above the channel beams, the keys being driven



RECONSTRUCTION DESIGNED FOR OPERATION DOWN SEVENTH AVENUE WITH CONNECTION TO PRESENT NORTHBOUND TRACKS



RAISING STREET RAILWAY TRACKS ON SEVENTH AVENUE OVER OLD SUBWAY TO GAIN CLEARANCE FOR RECONSTRUCTING ITS ROOF

through slots in the upper ends of these bolts. The shields could be slid along under the arches while hung from these bolts. The concrete was cut away above the shields by drilling it with air hammers and splitting it with plugs and feathers. This work was done without endangering the trains passing below, although the roofs of these trains cleared the old beams at places by a scant 3 in.

As fast as the old arches were cut out the shields were moved ahead and precast 2-in. concrete slabs, reinforced with Hy-Rib, were put behind them on the bottom flanges of the old roof beams. These old beams, except the few that interfered with the building of depressed bays for pipe crossings, were left in place.

HANDLING THE NEW STEEL

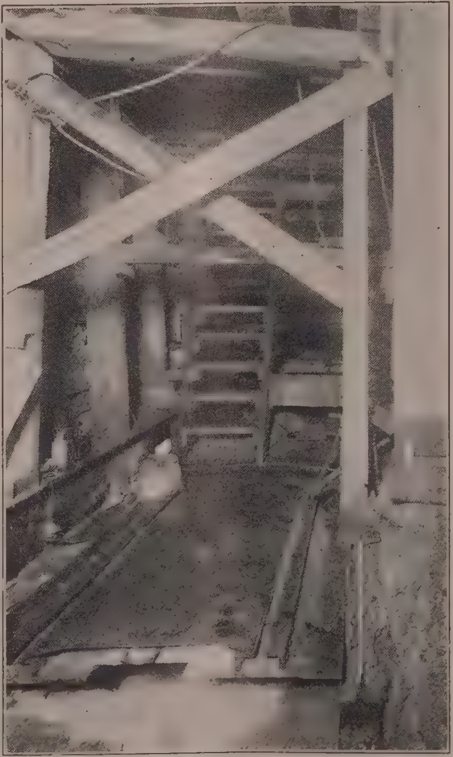
The triangular space between Broadway and Seventh Avenue, North of Forty-third Street, was fenced in and used for a yard by the contractor. Steel was delivered on the Broadway side and passed under the decking by two gallows frames, one on the north side of Forty-third Street and one inside the inclosure near Forty-fourth Street. The greatest distance any of this steel had to be handled beneath the decking was 100 ft. This was done by passing a member in parallel to Broadway, skidding in on top of the roof beams to place and turning it into position on steel rails laid on the old roof beams. This turning required some shifting of the posts under the decking, but this did not prove so troublesome as was expected. Each member was then left on rails directly over where it was to go, the work described being done largely by the day crew.

After 1.30 a. m., when express traffic was suspended, the night crew lowered as much as possible of this steel into position before 6 a. m., when express service was resumed. Two sets of chain blocks were used on each of the new girders, some of which weighed 7 tons, and 5-ft. rails were kept beneath them on the lower flanges of the old beams until the last minute as a precaution.

The columns, which were short, and many of which weighed less than half a ton, were lowered with manila rope falls. The old columns taken out were lowered to the express tracks in the same way after the top rivets had been cut off, and skidded to a hole left in the roof over the southbound express track at Forty-third Street and Seventh Avenue, where they were hoisted out with a gallows bent. The few roof beams removed were slid endways into the cut under Seventh Avenue.

SUPPORT OF GIRDERS ON EAST WALL

The support of the new girders on the east wall of the present subway fell midway between the existing columns. Reinforcing stirrups over the old columns and under the new girders were used to support them. The concrete in the tops of the panels between the columns of the old subway side wall was removed to permit the placing of this reinforcement.



STEEL SHIELD AT END OF TRAVEL ACROSS SUBWAY ROOF

Some of the new columns between the new express tracks at Forty-third Street are within the limits of the old southbound local track. In order to erect these columns the alignment of this track was changed to the west so that local-train operation may continue through the present subway until operation is begun southward along Seventh Avenue.

The roof to be carried by these columns was constructed previous to their erection, some temporary columns being used and vertical wells left to permit inserting a dolly to rivet up the column and bracket connections to the roof.

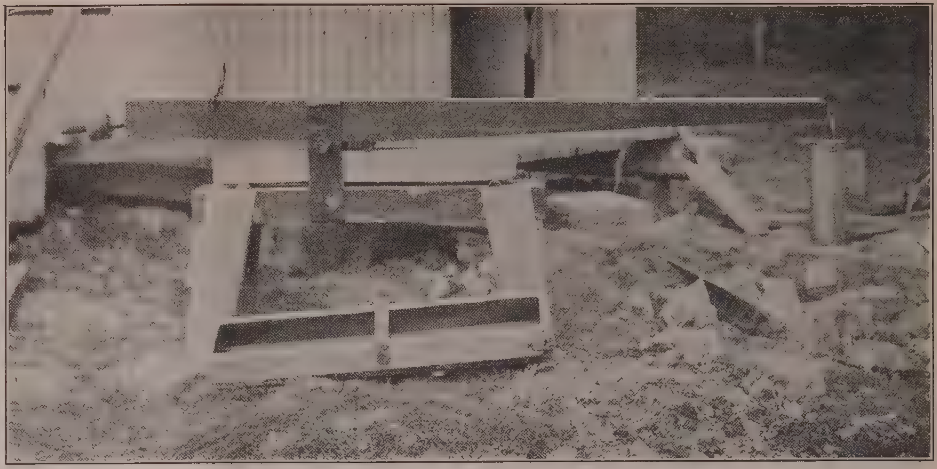
As fast as the new steel was placed the street load was transferred to it, and the slabs between girders were concreted. This buried the old beams several inches, as the new girders are deeper. In order that the car tracks shall go back to grade, slots had to be formed out of these slabs to receive the yokes referred to above. The concrete mixer is located at Seventh Avenue and Forty-third Street, and is fed with wheelbarrows. Concrete is distributed in carts, and poured through holes in the decking.

WORK UNDER SEVENTH AVENUE

The work under Seventh Avenue was similar to other decked street subway construction. When the excavation had been finished the west wall of the old subway was attacked with jackhammers and plugs and feathers. It has been entirely removed. The air plant for the drills, and the powder storage, were located in the yard referred to above. Material for this part of the work was handled through an opening in the east side of Seventh Avenue below Forty-third Street. A 5-ton Brownhoist locomotive crane, equipped with traction wheels, but running on a short track, served this shaft. These cranes do not have to boom up and down, but spot their load by swinging and moving on the track. Both motions are under instant control within 6 in. and the man in charge of the contract states that he believes this shaft plant more rapid than others used in New York. The excavation has not approached the handling capacity of the outfit. Storage space for dirt skips was provided above and below ground, so that the excavation was never delayed for lack of teams.

The Holbrook, Cabot & Rollins Corporation of Boston and New York is the contractor, its engineer, George Hallett Clark, being in direct personal charge of the work. The work is being supervised by the engineer corps of the Public Service Commission for the First District, of which Robert Ridgway is engineer of subway construction. Andrew Veitch, Jr., assistant division engineer, is in charge of the work on Seventh Avenue from Sixteenth to Forty-fourth Streets, and the work described in this article was under the immediate supervision of Emanuel D. Pildain, section engineer.

Field Testing Machine Used on Welland Ship Canal

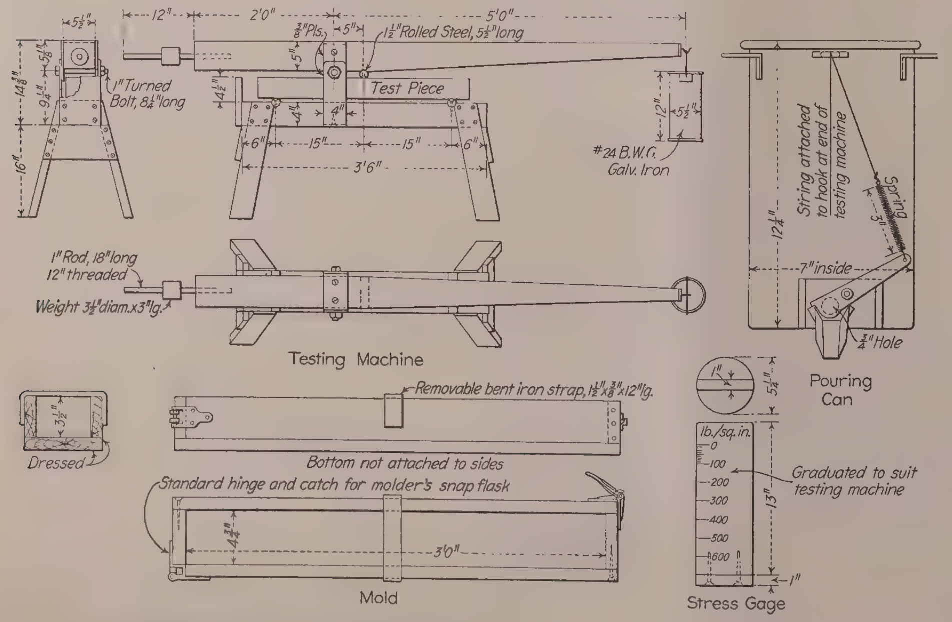


SIMPLE MACHINE USED FOR FIELD TESTS OF CONCRETE BEAMS

IN the construction of the concrete structures of the Welland Ship Canal it is required that field samples be taken during the progress of the work, formed into specimen beams, 4¾ in. wide, 3½ in. high and 3 ft. long, to be tested at specified ages. This work is done in the field office of each section where there is important concrete construction. Accordingly a cheap but satisfactory testing machine has been designed and is now in use. Details are given in the drawing, so that little explanation is necessary, while the photograph shows the machine set up, with the exception of the pouring can.

The load is applied by means of shot poured into the can on the end of the arm. The pouring can shown in the drawing is placed on a suitable stand and the gate opened. A string passes to the hook on which the loading can is hung so that when the concrete beam breaks the fall of the arm will close the gate. The spring on the end of the gate arm prevents the pouring can being thrown from its support. The breaking load of the concrete beam can then be read directly by means of the stress gage shown. The pouring can is made of No. 20 B. W. G. galvanized iron, is 7 in. in diameter, and has a sloping bottom so that there is no dead space.

The outfit was designed by Frank E. Sterns, designing engineer, under the direction of J. L. Weller, engineer-in-charge, Welland Ship Canal.


5½"
12"
2'0"
5'0"
⅜" Pls.
5"
1½" Rolled Steel, 5½" long
5⅝"
14⅜"
9¼"
16"
1" Turned Bolt, 8¼" long
5"
4½"
Test Piece
4"
4"
6"
15"
15"
6"
3'6"
12"
5½"
#24 B.W.G. Galv. Iron
1" Rod, 18" long 12" threaded
Weight 3½" diam. x 3" lg.
Testing Machine
String attached to hook at end of testing machine
Spring
3"
12¼"
7" inside
¾" Hole
Pouring Can
3½"
Dressed
Removable bent iron strap, 1½" x ⅜" x 12" lg.
Bottom not attached to sides
Standard hinge and catch for molder's snap flask
4¾"
3'0"
Mold
1"
5¼"
lb./sq. in.
0
100
200
300
400
500
600
13"
1"
Graduated to suit testing machine
Stress Gage

FIELD TESTING MACHINE, POURING CAN AND CONCRETE BEAM MOLD

Preliminary Surveys for Michigan Highways Cost $2.72 per Mile

PRELIMINARY surveys of 1200 miles of road to determine the best location for State trunk-line highways were made in one year (June, 1913, to June, 1914) by the Michigan State Highway Department at a cost of $3,269.40, or an average of $2.72 per mile, states Frank Rogers, State highway commissioner, in his latest biennial report. The cost would not have been that much except for the survey of the prime meridian, which, for the most part, traversed rough cut-over lands, more or less covered with brush, on which the survey cost $3.50 per mile. The prime meridian was surveyed for a distance of 150 miles.

On the preliminary surveys the following information was obtained (when any controversy arose, the lines were fully mapped):

1. Character of country traversed; timber, cut-over lands—character of stumps; clearing; improved farms.
2. Approximate location of buildings; kind.
3. Condition of road grade, if any. (a) Approximate width, (b) alignment, (c) drainage.
4. Kind of soil on roadway—(a) sand, (b) clay, (c) loam, (d) swamp.
5. Location, condition and size of ditches, creeks and streams that must serve as outlets for water from the roadway.
6. Condition, location and measurement of present culverts and bridges.
7. Photographs of all truss bridges and others that might need to be repaired or rebuilt.
8. Bearings of roads traversed with compass.
9. Intersections within corporate limits of cities and villages.
10. Slope, length and height of hills where grade exceeds 5 per cent.
11. On traveled roads, number and kind of vehicles passed, to make possible some estimate of public traffic.
12. Notes as to available road material, gravel, stone, etc.
13. Approximate estimate of cost of grading per mile.

Complete location surveys and plans were made for 299.45 miles of trunk lines at a total cost of $12,039.69, or $41.60 per mile.

Ohio Highway Statistics

HIGHWAY statistics as compiled in Bulletin 23 of the State highway department show that Ohio has 55,268 miles of earth road, 15,652 miles of gravel, 12,144 of macadam, 440 miles of brick, 78 of concrete and 99 of miscellaneous types. In 1914 contracts were let for 495 miles of road which included 157 miles of brick, 120 of plain surface concrete, 181 of plain macadam, 26 of bituminous macadam, 4 of gravel and 6 of graded road. Ohio's yearly road construction mileage has increased from 33 miles in 1906 to 495 miles in 1914. The average cost per mile for the 307 miles of roads repaired in 1914 amounted to $625. In 1906 $10,332 was spent for new road construction and in 1914, $1,567,248. The State received $2,261,256 in 1914 for road improvements—its share of the 0.3 mill on Ohio's grand tax duplicate of $7,537,486,981.

THE AUTHOR of the article on the Point Defiance line of the Northern Pacific Railway in Washington, published in the Engineering Record of June 12, page 744, was David L. Soltau. In the article in question his name was spelled Soltan.

Severe Frazil Ice Attack at Holtwood Plant Does Not Disturb Service

Experience Has Also Enabled Conclusions to Be Drawn as to Effectiveness of Methods and Warning Signs—Changes and Experiments to Be Made

By F. A. ALLNER
General Superintendent, Pennsylvania Water & Power Company, Baltimore, Md.

IN AN ARTICLE in the last issue of the Engineering Record there was described the standardized operating precautions adopted by the Pennsylvania Water & Power Company to ward off trouble from river ice. It was there shown that the Susquehanna River is subject to frequent and severe jamming from ice packs, but that interference to service from such pack ice has never been experienced nor expected. However, strange to say, for a river located so far south frazil and anchor ice have been a menace and so necessitated the precautions outlined in the previous article. There have been three occasions when, due to frazil or to anchor ice, the operation of the plant might have been expected to be interfered with.

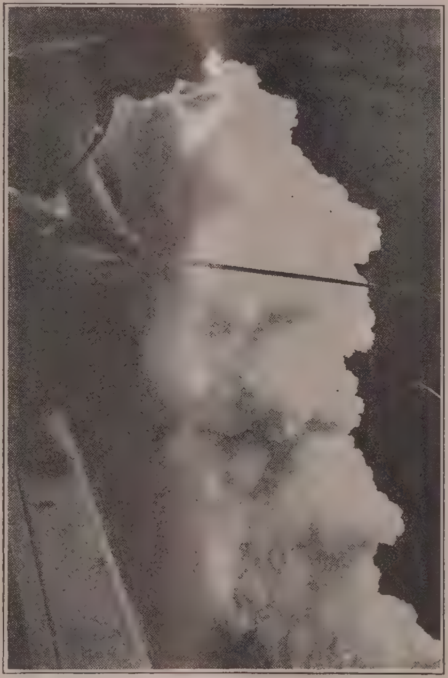
This article will outline very briefly the effects of the first two on-sets of frazil ice, but will discuss in considerable detail the operation during the third on-set, at which time the standard operating precautions were in force. The operation during the third attack indicates that frazil ice conditions, which formerly might have been considered very threatening to the service, have been met quite effectively and rendered harmless by a standardized operating procedure based on experience and experimentation.

WEATHER CONDITIONS

During the night of Jan. 29-30 the sky was clear and cloudless, but there was a 7 or 8-mile wind blowing, which was sufficient to keep the water in the pond from freezing over, except near the shores. A strip about 300 ft. wide along the York County shore was frozen over, as was also a space included within a line from the end of the ramp to the lower end of McCalls Ferry. There was very little evidence of floating slush ice. The forebay was about six-tenths covered with ice, the lower end being covered to Unit 7.

The day and night previous were cold and windy. During the night of Jan. 28 and early morning of Jan. 29 the sky was clear and a 20 to 30-mile wind was blowing. Frazil ice was expected at this time, but the water was probably not cold enough.

The air temperature during the night of the trouble decreased from — 6 deg. C. at midnight to a minimum of — 10 deg. C. at 7 a. m. and the water temperature from 0.6 deg. C. at midnight to a minimum of 0 deg. C. at 10 a. m. At 4 a. m. the air temperature was — 8 deg. C. and the water temperature 0.6 deg. C.; the forebay elevation, 167.7 ft.; the river flow, 80,000 sec. ft.; station load, 16,000 kw. Units 3, 5, 6 and 7 were running, and exciters 2 and 3 in service.



FRAZIL ICE ON SCREEN, JANUARY 30

PRECAUTIONS

In accordance with the operating instructions chains had been hung in the forebay for the purpose of detecting ice and No. 1 turbine-driven hand-control pump was running at a reduced speed so as to indicate the presence of ice in its penstock. The gatehouse steam boiler and the dinkey locomotive were in readiness with banked fires; hose and piping connections were in readiness to supply steam in the power-house air-piping system for warming the exciters and main unit wheel pits. No. 1 waterwheel exciter was on standby with its screens out. No. 2 motor-driven exciter was in service. Readings were taken on air and water temperatures in the forebay every half hour and a constant watch was kept on the test chains. All screens had been removed since the beginning of the winter season from one intake of each unit and the headgate left down to be raised on the first sign of ice.

The screen follower for lifting submerged screens had, in addition to the original trials, been tested and the men drilled in its rapid handling just previous to the day of the trouble to make sure that everything was working properly.

FIRST SIGN OF TROUBLE

Ice was first discovered at 3.55 a. m. when it began to form on one of the gatehouse test chains. The substation at Lancaster was notified of the ice beginning to form at 4.05 a.m. and the Baltimore substation at 4.08 a. m., and some of the day maintenance men were called out.

At the same time one of the screens on Unit 1 was lifted and some small blotches of ice, about 1¼ in. in diameter, were found. One of the screens of No. 3 unit was then lifted; about half the submerged area showed ice attached.

Previous to 3.55 a. m. No. 1 hand-control pump had shown signs of slowing up, but no evidence of ice could be found in the forebay. About the time that decided evidence of ice was detected on the forebay chains, the pump shut down completely. The handhole covers were taken off but no ice was found in the runners nor did any amount of water come through when the turbine valve was opened, indicating that the screens of the turbine penstock had clogged.

HANDLING HEADGATES AND SCREENS

At 4.15 a. m. the fourth headgates on Units 3, 4, 5, 6, 7 and 8 were raised. The screens of exciter 3 were raised at about the same time and the boiler and dinkey started. At 4.25 the fourth headgates on units 1 and 2 were raised. At 4.35 a. m. there were no signs of ice on the water sur-

TABLE 1—TIME OF REMOVING SCREENS AND THICKNESS OF FRAZIL ON THEM—ICE RUN OF JAN. 30, 1915

Screens	No. 1 Unit				No. 2 Unit				No. 3 Unit				No. 4 Unit				No. 1 Exciter
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
A	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out
B	5.36 a.m. ½ in.	5.34 a.m. 10 in.	4.00 a.m. 10 in.	Out	5.30 a.m. 0 in.	5.28 a.m. 0 in.	5.26 a.m. 0 in.	Out	5.32 a.m. 5 in.	5.38 a.m. 5 in.	4.05 a.m. ½ in.	Out	5.41 a.m. 2 in.	5.43 a.m. 2 in.	5.45 a.m. 1 in.	Out	Out
C	7.13 a.m. 10 in.	1.25 p.m. 24 in.	8.10 a.m. 14 in.	Out	3.40 p.m. 13 in.	1.45 p.m. 15 in.	6.52 a.m. 4 in.	Out	4.35 p.m. 14 in.	2.00 p.m. 18 in.	11.35 a.m. 30 in.	Out	4.43 p.m. 15 in.	2.20 p.m. 18 in.	8.25 a.m. 14 in.	Out	Out

Screens	No. 5 Unit				No. 6 Unit				No. 7 Unit				No. 8 Unit				No. 3 Exciter
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
A	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out	Out
B	5.47 a.m. 2 in.	5.49 a.m. 2 in.	5.51 a.m. 1 in.	Out	5.54 a.m. 3 in.	5.58 a.m. 3 in.	6.04 a.m. 4 in	Out	5.00 a.m. 4 in.	12.30 p.m. 12 in.	5.10 a.m. 2 in.	Out	5.15 a.m. 0 in.	5.17 a.m. 0 in.	5.20 a.m. 0 in.	Out	4.15 a.m. 0 in.
C	4.57 p.m. 16 in.	2.35 p.m. 30 in.	8.45 a.m. 18 in.	Out	5.00 p.m. 14 in.	2.48 p.m. 14 in.	10.45 a.m. 12 in.	Out	5.07 p.m. 0 in.	3.15 p.m. 14 in.	10.05 a.m. 18 in.	Out	5.15 p.m. 0 in.	3.28 p.m. 8 in.	11.25 a.m. 24 in.	Out	4.20 a.m. 0 in.

NOTE—Each main unit has four intakes, with five screens in front of each. The fourth and fifth screen sections, designated as D and E, were not removed, except that section D had in the early winter been removed, with A, B and C in the fourth intake as a precautionary measure. See last week's article for full explanation.

face in the gatehouse, nor was there any noticeable drop through the screens. About 1½ in. of ice had formed on all ropes and test chains.

At 5 a. m. the pulling of the second screens was in full swing and the screen pulling continued, as indicated in Table 1. At first the screens showed from 1 to 4 in. of ice, depending upon which units were running, the running units, of course, having more ice on their screens. At 6 a. m. the greatest thickness of ice observed on any of the screens was 4 to 5 in. From then on each screen pulled continued to show heavier ice, the maximum observed being about 30 in., measured from the face of the screen.

DIFFICULTIES WITH LIFTING DEVICE

Up to about 7 a. m. the screen pulling was progressing normally and was well in advance of the station load. At about this time, when the third sections started to come out, the screen follower, which was used to get hold of the submerged screens, started to give trouble.

The first difficulty with the follower was that the screens had become so heavily coated with ice that the follower hooks were unable to get hold of the upper channel. The ice had also accumulated to a thickness of 12 to 14 in. on the guides above the screens, preventing the follower from getting within reach.

The second difficulty was that the side angles on the follower were a little too short to keep the follower in the screen guides, making it very difficult to keep the pull of the crane cables in line with the direction of the screen guides as the horizontal component of the pulling force, plus the added weight of the heavy ice coating, would slide the traveller along the rails so as to swing the cables out of line.

USE OF GRAPPLING HOOKS

It was then decided to abandon the use of the follower and to use grappling hooks. There was difficulty in using the hooks on account of the heavy accumulation of ice, and also because when the screen was lifted out of the water a man then had to go down and break the ice off the top of the screen so as to get a steel-rope sling through it. The small hook on the crane was then lowered and used to hold the screen while the big hook was slackened to release the grappling hook. The big hook was then put through the rope sling, the small hook released and the screen brought up. As the screens, loaded down with ice, were very heavy the grappling hooks repeatedly straightened out and new ones had to be supplied.

This method of course caused considerable delay in handling the screens and necessitated the gradual assistance of the Westport steam station for the safe carrying of the load over the peak.

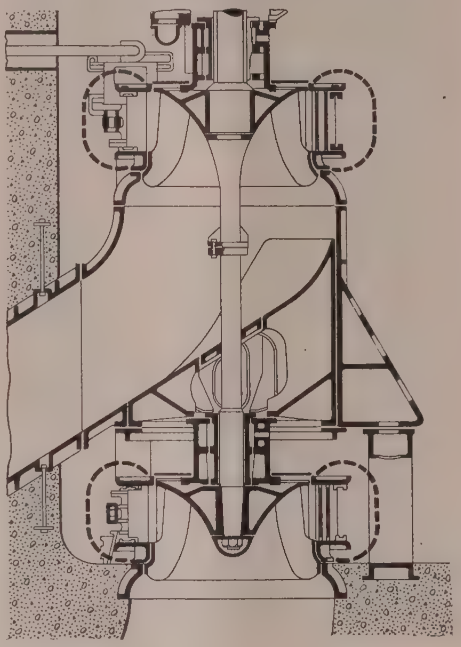
EXCITER CAPACITY ALWAYS AMPLE

At about 6.55 a. m. No. 3 waterwheel exciter started to show signs of reduced capacity and load was transferred to the spare exciter which was in readiness. Steam was then admitted to the exciter which had been running, thus thawing out the ice and warming up the pit so that it was ready to take care of the load when the other exciter clogged up, which it started to do in about two hours.

No difficulty whatsoever was experienced in taking care of the excitation, as the exciters did not clog up quickly, so that while one exciter was running there was more than enough time to thaw the other out and get its pit warm. As the running turbine-driven exciter was kept heavily loaded, practically the entire capacity of No. 2 motor-driven exciter was available at all times, to say nothing of the storage battery. The periodic changing over of the turbine-driven exciters and the thawing out with steam were continued until the trouble ended.

TABLE 2—LOAD CONDITIONS JAN. 30, 1915

Time, a. m.	Station Capacity, kw.	Station Load, kw.	Westport Steam, kw.
6.00	47,000	35,000	......
6.30	54,000	42,000	......
7.00	54,000	38,000	10,000
7.30	54,000	42,000	10,000
8.00	52,000	49,000	8,800
8.30	50,000	47,000	11,000
9.00	48,000	42,000	12,300
9.30	50,000	40,000	7,000
10.00	50,000	42,000	2,000
10.30	50,000	44,000	2,000
11.00	65,000	44,000	2,000
11.30	65,000	47,000	......
p. m.			
12.00	65,000	45,000	......
12.30	65,000	44,000	......
1.00	65,000	45,000	......
1.30	76,000	47,000	......
2.00	76,000	49,000	......



BROKEN LINES INDICATE ICE ACCUMULATION AROUND VANES

ICE IN THE WHEEL PITS OF MAIN UNITS

At about 8 a. m. the main units started to give indication of ice forming in the turbines. This was evidenced by the units not increasing in capacity, in proportion to the number of screens removed. To overcome this trouble the turbine vanes were moved back and forth. This was successful in breaking the ice in all units and bringing them to full capacity, except No. 5, whose capacity stayed at about 40 per cent. No. 5 turbine was taken out of service at 11.35 a. m. and opened for examination. The entire upper runner was found enveloped in ice. There was no ice on the concrete nor on the operating shaft or reach rods, but the vanes were fixed quite immovably with the ice surrounding them, as indicated in the accompanying sketch. Steam was admitted to the unit for about an hour, and upon being again opened, it was found that the steam, while it had not melted the ice appreciably, had softened it considerably. The pit was then filled with water and after manipulating the vanes a few times, the ice broke. The unit was put back in service and delivered full capacity. After it had been running for about an hour on the bus the unit was again opened and examined and no trace of ice was found.

At 2.40 p. m. No. 3 unit, which was now delivering full power but which had previously shown signs of reduced capacity, was opened and examined. Ice was found on top of the runner, with a large accumulation near the water intake for the lignum vitæ bearing. Some ice adhered to the operating shaft, especially on nuts and bolt heads, and also in a few places to seams and irregular places in the concrete. This ice was softer than in No. 5.

Table 2 shows the station capacity, station load and Westport steam load every half hour during the trouble, indicating that at all times the station capacity was well in excess of the station load, in accordance with the rules of the Permanent Operating Instructions for fighting imminent ice trouble.

IMPROVING SCREEN-HANDLING DEVICES

In reference to the difficulties with the screen follower, these can be remedied by lengthening the side angles to at least 6 ft. long. The hooks should have a length of about 3 ft. to clear the head of ice on the submerged screen, and in order to make the follower pull in line with the guides the crane traveler should be fastened on the rails in the proper position by chains that can be hooked in when required.

A previously proposed scheme of connecting the second and third screens so that when the second screen is lifted the third one comes with it, thus giving a large free opening for the water, will save considerable time in handling the screens. This will make it necessary to remove the second screen from the guides before starting to raise the third screen.

Contrary to expectations of last year there seemed to be no difference in the amount of ice which formed on the painted and unpainted screens, although the painted channel-iron gage at the river end of the station again showed very little ice while the unpainted iron ladder alongside of it had an accumulation of about 12 in.

During the next season three special test pieces, one with blank metal surface, the second one with the standard two coats of red lead and a third one with a very heavy coating, will be suspended in a characteristic location in the gatehouse in order to determine definitely the comparative influence of paints or other heat insulating coats on the formation of frazil ice.

EFFECTIVENESS OF STEAM

In regard to the effectiveness of steam in getting rid of the ice in the wheel-pits, it can be said that in the case of the exciters which were examined at frequent intervals during the trouble, that steam is very effective. On the large units the masses are so great that it takes longer for the steam to have an effect, but it has been noticed that steam applied to one of the main units for one hour will loosen up the ice considerably; applied for one to two hours it will cause the ice to become so rotten as to drop of its own weight and if for three or four hours the ice which forms within the runner drops off. This has been verified by later experience.

If the vanes are kept moving constantly they can not freeze solid, but some ice will form on the inside tips of the vanes and also on the leading side of the runner blades, which must be thawed out by steam if the condition is serious. Experience has also shown that steam acts as a very prompt remedy when applied in the incipient stage of ice sticking to the turbine parts. On large masses of ice the effect of steam is considerably slower.

It was observed that the ice deposit was greatest where the velocity of water was highest. Such was the case in No. 5 unit, which had 12 to 14 in. of ice around the vanes and operating rings and elsewhere had none whatsoever. Obstructions, rust, barnacles, nuts, etc., seemed to be favorite starting points for ice clusters.

SINGLE-RUNNER UNIT BETTER PROTECTED

Unit 8, with its scroll case, has no protruding parts obstructing the flow of the water and when it was examined during a later ice flow, no ice was found adhering to any part of the turbine although some did adhere to cracks and rough spots in the concrete intake. It is very likely that the freedom from ice around the guide vanes of this unit may be due to the turbine parts conducting considerable heat from the warm air in the building to the water exposed surfaces, as the head cover of No. 8, with guide-vane spindles, etc., is exposed to the warm temperature of the operating chamber.

NEW FACILITIES FOR DETECTING TROUBLE

At some subsequent occurrence of frazil ice (Feb. 10 and 11, 1915) of less severe character than on Jan. 30, the small 50-hp. turbine driving the geared hand-control pump No. 1, invariably gave a very distinct warning about one hour ahead of any other observation of ice, on test chains, screens or other metal parts. This automatic alarm is very effective as it acts as an acoustic signal due to the change in the noise of the gears. There is one attendant permanently stationed in close proximity to hand-control pump No. 1 at all times and this warning can not go unheeded.

In order to still further increase the rapidity of ice formation on the screens that guard the 14-in. penstock leading to the 50-hp. turbine, a much finer mesh than employed in the present screen bars will be inserted. The principle of this idea could also be applied further to a more elaborate combination of a water jet controlled by such a screen-covered inlet, with an automatic alarm device transmitting the warning as an acoustic, optic or other kind of signal directly to the bench-board operator.

Another feature that will assist in determining ahead of time the critical climatic factors favoring the formation of frazil ice will be the new graphic thermometer that is now being installed in the gatehouse, having a chart of large scale around the critical temperature range for frazil ice.

COMPARISON WITH PREVIOUS ICE-RUNS

Previous to Jan. 30, 1915, the Holtwood plant was exposed only twice to frazil ice, Jan. 5, 1912, and Feb. 14, 1914.

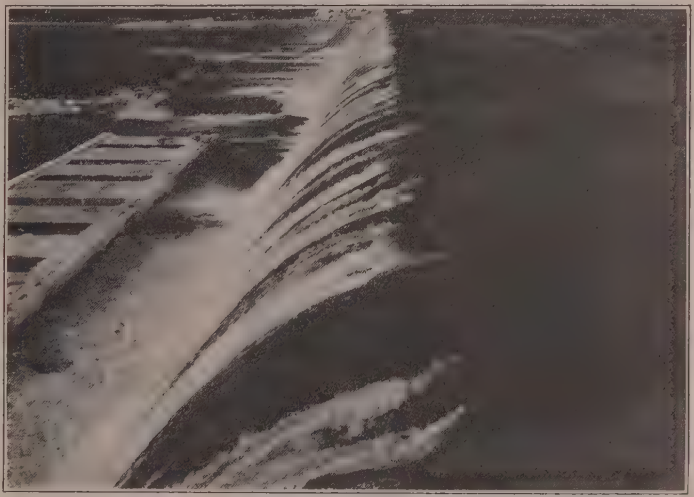
Jan. 5, 1912.—No clogging up of the guide vanes on main units was observed on this occasion, and the disturbance to service was due to two causes, (1) the clogging up of the intake screens while proper facilities for removing them quickly were not available at that time; (2) the clogging of the runners (not guide vanes) in two small turbine-driven exciters after the removal of the screens. A motor generator exciter was at that time in process of installation but not yet available for service. Since then the alternating current driven exciter and the installation of an excitation storage battery of ample capacity has removed the danger from this source completely.

Feb. 14, 1914.—The reduced station capacity on this occasion was again due to the clogging of the screens. Although slight adhesion of ice occurred at the guide vanes, one is inclined to ascribe this to the fact that the operator permitted his water level in the pit to drop below the intake of the upper runner, the cold air then chilling the machinery parts around the intake excessively. With the wheel-pit gages mounted on the floor and the precautions given in our standard instructions for handling such trouble, there should be, in future, no difficulty whatever in the wheel pits being kept filled.

Jan. 30, 1915.—This is an occasion where the ice conditions were severe, but due to the methods of handling ice menace as developed from previous experiences, no interference to service resulted, although one main unit (No. 5) had its guide vanes (and probably also its runners) well clogged up, while the turbine-driven exciters suffered, at intervals, slight reductions in capacity. The waterwheel exciters were easily kept sufficiently clear with the assistance of steam. It could not be stated definitely whether any ice formed in the runners or about the guide vanes of these exciter wheels, because it was not necessary to inspect the exciter pits during the ice run. From previous observations, however, one is inclined to ascribe the occasional reduction of the exciter output to the formation of ice in the runner.

The fact that ice clogged up the guide vanes of main unit 5 is ascribed to the extremely severe conditions during this ice attack, and it is believed that probably any other type of turbine gate mechanism would have met with the same difficulty. On the other hand, it is believed that the movable-vane type of mechanism assisted materially on this occasion in clearing the water passages, for after a short application of steam had rotted the ice, the latter was easily broken up and cleared out by moving the guide vanes.

COATING OF ICE MAKES IT HARD TO GRIP SCREENS WITH HOOKS



FRAZIL ICE, ADHERING TO CREST OF DAM, RAISES WATER LEVEL

The practice of keeping the guide vanes steadily in motion during ice trouble probably helps a great deal to keep the openings clear. In the case of unit 5 on Jan. 30, it is believed that the moving of the vanes was not attended to properly by the operator during the initial stages of the ice run.

CONCLUSIONS

In regard to the possibility of further ice trouble at the Holtwood plant, there need be no more fear of the clogging of the screens or turbines, reducing the station capacity, as with the improvements now under way, and the method of handling the screens so that they can be taken out so quickly, the station capacity will suffer no appreciable reduction due to obstruction of the flow at that point.

There may be some obstruction to the flow of the water through the turbine, due to the ice packing in the runners, but on account of the various telltale devices that are now available to indicate imminent ice trouble, to say nothing of the better experience in regard to weather observations favorable to frazil ice, this can only occur with such forewarning that the necessary standardized precautions can always be taken with ease and such effectiveness as to prevent any disturbance to the service. All work necessary for handling ice trouble successfully has been carried out easily by the regular station shift force, assisted only by a few maintenance men who take care of the steam treatment, inspection of wheel pits and other extra work of special character.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Canoes with Detachable Motors for Survey Parties

SIR: Some time ago there appeared in the Engineering Record an article on the use of canoes in survey work. The following data may, therefore, be of interest.

During the month of December, 1914, our party of four—G. K. Little, U. S. assistant engineer in charge of the Warrior River improvement, Alabama, with J. B. Battle, R. A. Meredith and myself, spent eleven days on the river above Lock and Dam 17. The trip was made to determine the value of the land that is now submerged by the filling of the pool above the dam.

We used for the trip two 18-ft. Old Town canoes equipped with 2-hp. detachable Evinrude motors. In these canoes we carried camp equipment, provisions, etc., and with each canoe loaded and carrying two men we made about 10 miles an hour. During the eleven days in the field we traversed approximately 500 miles, or nearly 50 miles a day.

On crossing shoals, we experienced little trouble, as our equipment was packed in "one-man" packs, and the canoes weighed only about 75 lb., while the motor weighed 50 lb.

Where conditions will permit engineers will find that this equipment will prove quite satisfactory. Progress is fast and pleasant. The Old Town stands the roughing, while the Evinrude is a "sure go" and good for 25 miles on one gallon of gasoline.

I used the two motors during January on two 20-ft. yawls carrying camp equipment, provisions, etc., with a party of eight for survey work on the upper river. With yawls loaded we traveled at an average speed of 4½ miles an hour, going about 12 miles on a gallon of gasoline. On one occasion we shifted our camp 41 miles in one day.

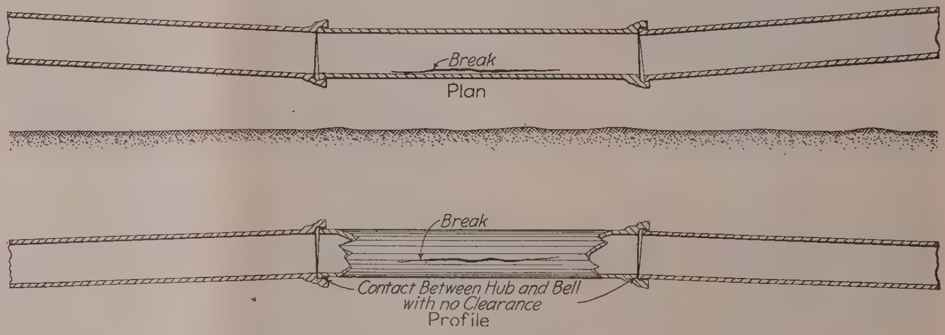
JAMES B. ABBOTT, JR.,
Contracting Engineer.
Tuscaloosa, Ala.

New Theory of Cast-Iron Water Main Breaks

SIR:—In the issue of the Engineering Record of May 8, page 588, are given the findings of J. W. Alvord on the break of a 60-in. cast-iron water main in Cincinnati on Dec. 6, 1913, which ascribed the cause to end pressures. In April of the current year our 20-in. supply main broke under the same general conditions as regards insufficient end clearances.

Herewith is a sketch of the main at the point of the break. The bottom or lower edge of the spigot and hub of the adjoining pipes and the north edge of the spigot and hub of the adjoining pipes had no clearance whatever. What does not seem perfectly clear is why the pipe should crack at the side opposite to which the compression would occur. I believe the crack on this side to be due to the fact that, a few days before, the main had to be closed and the increased pressure and slight amount of water hammer would have a tendency to expand the pipe or burst it. This bursting tendency was counterbalanced on the north side, under compression, and had nothing to withstand it on the south side or convex part of the curve but the strength of the pipe itself.

The pipe is laid on the north side of the State highway, with the convex part of the curve about 2 ft. from the road surface which is telford macadam. From the concave side of the curve to the property line there are about 10 ft. and just inside of the property line the cane teams of the sugar mills pass by, the ground being very soft. If the pipe had any tendency to move it must have been to straighten out. This of course would cause the end pressures on the concave side to increase, and this is my question: In a cylinder with one edge under compression, what is the nature of the stresses in the edge diametrically opposite, this edge being free?



LOCATION OF BREAK IN CAST-IRON WATER MAIN IN CIENFUEGOS, CUBA

In placing a new pipe we had to dig up the line for five pipe lengths and ease off the curve in order to have sufficient clearance. The broken pipe was in excellent condition. A milkman notified us at 10 a. m. and we reached the break in an auto at noon and with portable telephone called up a pipe team, brought a pipe stowed at a distance of 2½ miles, closed the main at 6 p. m. and by 5 a. m. next morning had the new pipe in place and the water flowing into the town reservoir.

FRANK M. AGUIRRE,
Chief Engineer, Cienfuegos Water Supply and Sewerage Systems.
Cienfuegos, Cuba.

Hydraulic Measures Vetoed in Pennsylvania

Sir:—In order to correct what appears to be an erroneous statement contained in the issue of the Engineering Record of July 10, under the heading "Hydraulic Measures Vetoed in Pennsylvania," wherein it is said the Governor "also reduced the appropriation for the stream gaging work to $10,000, thus practically putting a stop to the great work which the Commonwealth had in hand," I beg to advise you that the real facts are: The general assembly appropriated to the Water Supply Commission $50,000 for this work, but, owing to insufficient State revenue, the Governor was compelled to approve this item in the sum of $40,000, which is the same amount received by the hydrographic division two years ago. The amount approved will enable the commission to continue its hydrographic work without interruption along the high standard established by the State of Pennsylvania.

R. A. BOEHRINGER,
Division Engineer, Hydrographic Division.
Harrisburg.

Simple Solution of a Quadratic Equation by Slide Rule

SIR: Saul Shaw, who writes on the above subject in your issue of June 12, page 754, is evidently not well acquainted with slide-rule literature, or he would have known that the method he has "discovered" was in use some twenty years ago. In the eighth edition of my little book, "The Slide Rule," I described this method of solving quadratics and also showed its application to the solution of cubic equations. But various processes of the kind had been described previously by M. Beghin and others. I would add that in later editions of my book this section has been omitted, the space being required for matter of more practical value.

C. N. PICKWORTH,
Consulting Engineer.
Manchester, England.

A LARGE RELIEF SEWER has been started in Forty-first Street, New York City, under the supervision of the New York Public Service Commission, First District, to drain the area in the vicinity of the Grand Central Terminal. It will extend down Madison Avenue from Forty-third to Forty-first Street, and thence through a rock tunnel from 40 to 45 ft. below the surface eastward under Forty-first Street to the East River. That part from the west side of Park Avenue under the existing subway and to a point slightly beyond Third Avenue will be constructed by the Rapid Transit Subway Construction Company as part of its contract for the connection between the old subway and the new Lexington Avenue line. The rest of the work will be done by contractors for the city under the supervision of the Manhattan Bureau of Sewers. The work was started at the site of the proposed shaft at the southeast corner of Lexington Avenue and Forty-first Street. Robert Ridgway, engineer of subway construction for the Public Service Commission, turned the first shovelful of earth after it had been loosened by a pick wielded by R. A. Shaler, tunnel engineer of the Rapid Transit Subway Construction Company. The cost of the entire work will be about $240,000.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Pavement Rooter Drawn by Street Cars Tears Up Brick Streets

A HEAVY pavement rooter in use in Cleveland recently tore up 1475 ft. of granite block pavement between two street-car tracks in three minutes. The rooter consists of a heavy steel casting shaped so as to slide under and lift the paving blocks, mounted beneath a substantially built carriage which weighs complete about 11 tons. This plow is drawn along by a trolley car at about 500 ft. per minute. Including the time taken to set the plow in position, the entire operation took but 12 min. Two men ride the plow besides the crew of the motor car.

PAVING THOROUGHLY TORN UP

Owing to the speed at which the rooter traveled, it was difficult to catch it in action. One of the photographs shows it at work, but when the camera was snapped, the car drawing the plow had almost passed out of range to the left.

"ROOTER" MOVED SO FAST IT WAS DIFFICULT FOR CAMERA TO CATCH IT

Paint Twin Cableways Red and Blue for Electric Signal System

By HAROLD E. KETCHUM

Superintendent, Hunkin-Conkey Construction Company, Cleveland, Ohio

A SINGLE pole knife-switch attached to 100 ft. of lamp cord, which can be plugged in at intervals on a line buried in the ground, has proved the best means of giving signals for operating the large twin cableways that are building the Detroit-Superior high level bridge at Cleveland. Three wires, one for each cableway and one for a field telephone, are buried in ordinary ½-in. conduit along one side of the line of the piers. There is a wooden box of 2-in. plank with a hinged cover and padlock at each pier. This box is sunk into the ground, and inside it the conduit is raised above ground to prevent wetting the connections to the three condulets located in the box. These condulets, one for each cableway and one for the telephone, are fitted with receptacles for 2-prong connection plugs. Each signal man carries around with him a knife switch and 50 to 150 ft. of cord fitted with a plug. Satisfactory results have not been obtained with push buttons, though several styles have been tried out. By this means the signal men are able to stay close to where the load is being handled, plugging their line in where convenient.

In order that no confusion should arise as to the place to insert the plugs, each cableway has a color. One cableway, its engine house, carriage and fall block, is painted red, and the other blue. One end of each outlet box is painted red and the other end blue, and the receptacles are red and blue respectively, while the center receptacle is left white. It is connected with the telephone line. The cableways are known on the job as the red and blue, and are always so referred to.

WATCHING HIS LOAD AT CLOSE RANGE WHILE SIGNALING WITH KNIFE SWITCH

At each engine house a 4-in. moisture-proof electric bell is provided for signaling. As an extra precaution a small 3.8-volt electric bulb is also used. The bell and light are operated by a relay, similar to a telegraph relay, which is controlled by the signal line. This arrangement gives a quicker, stronger, and more positive signal. With this arrangement the signals are always the same strength, no matter how far away the signal man's switch is plugged in. By the use of the light, five independent signals can be given in two seconds.

Can the Small Contractor Afford an Engineer?

AN EASTERN sewer contractor who, some years ago, discovered for the first time that college men are trained to think, is ready to answer the question "Can the contractor afford an engineer?" with an emphatic yes. In his opinion many small contractors taking jobs amounting to $100,000 or less cannot afford to run such work without engineering assistance.

This man had employed engineers, but did not consider their services essential. Some years ago he assigned to a sewer contract a young engineering graduate, chiefly because of his friendship for the young man's father. He paid no particular attention to what this man was doing, and did not seem to care whether he stayed on the job or not. Consequently the fellow left. At once things began to go wrong, and the contractor found annoyances springing up from which he realized that he had been free during the past few months. The engineer was hunted up and induced to return. At the end of the job the contractor was about to approve the final estimate for the work, although he had a dim suspicion that there was something the matter with it. His engineer examined this estimate, however, and soon convinced him that errors and omissions amounting to more than $10,000 had been made by the city engineers. A protest resulted in the work's being remeasured, and the full sum added to the estimate.

This man on a pipe contract had been in the habit of ordering his special castings in a lump, storing them all at one place, and not distributing any of them until he had to have them for immediate use. The natural result was delays and long trips for a single light casting, which took up the time of his teams. The engineer had all special castings for each territory stored together at a convenient place in that territory, and when a given line was to be laid a truck would pick up all the special castings marked for that line and distribute them where they were wanted at a single trip.

Another apparently trifling thing on which this engineer saved his employer much money was in having the lengths of pipe turned properly when they were delivered to the trenches, so that they did not have to be returned by hand. Cast-iron pipe is laid, of course, with the bell up hill on a grade. The engineer located for the foreman all the grades and grade changes on each line, so that the trucks could be turned right before the pipe was unloaded.

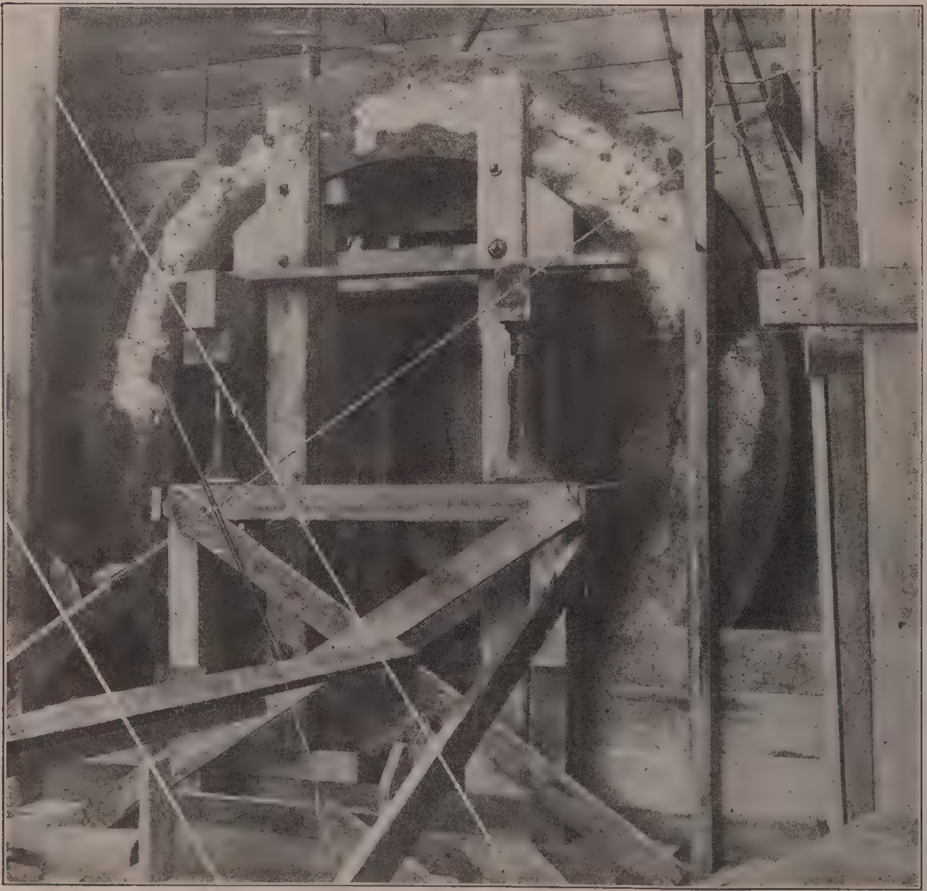
Heating Hub of Turbine Spider Saves Four Days' Time in Mounting

By HAROLD F. JOHNSTON
Banff, Alberta, Canada

INSTEAD of taking four days to put a 27-ton spider on a 15-in. shaft with a 100-ton hydraulic press an erection superintendent in Canada recently succeeded in making a satisfactory mounting in less than four hours by heating the hub of the spider enough to expand it a little. The cost of mounting the spider in the press would have been $60, while the actual operation performed cost only $5. As time was a most important factor in the contract, however, the saving of over three and one-half days was of much more value than the small saving of labor.

This spider carried the rotor and field coils. It had to be keyed to a 15-in. vertical shaft directly connected through a coupling to the turbine shaft. The shaft was first mounted, and the coupling bolted up. The spider, on which the field coils had already been mounted, was blocked up about 9 in. off the power-house floor. A ring of sand was then built around the outside of the hub, forming a pit under the hub in which a fire of dry pine chips was built. The top of the hub was covered with steel plates to help confine the heat. One man kept tending the fire, keeping it evenly hot all around the hub for three and one-half hours. The spider was then raised by the crane and easily fitted over the shaft. It was quickly turned to the proper position, the key driven home, and the mounting completed. The job proved entirely satisfactory, and the 100-ton press sent out by the contractor to comply with the specifications was returned unused.

The installation was made by the General Electric Company of Sweden, at the plant of the Calgary Power Company, at Seebe, Alta. Two 12,000-volt, 4200-kva. generators were erected.

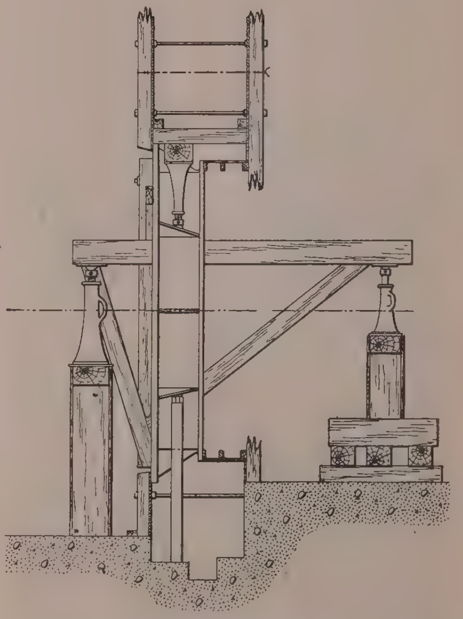


RING, HELD ON FRAME, WAS ALIGNED WITH JACKS, AND FORM BUILT AROUND IT

Eight-Ton Casting Hung in Place in Form on Special Frame

By F. M. BIERSACH
Erection Superintendent, Allis-Chalmers Manufacturing Company

SUPPORTING an 8-ton bulkhead-ring casting in exact position on the shaft center line while a concrete penstock wall was being poured around it was accomplished successfully as illustrated by the accompanying sketch and photograph. The ring was first raised to a vertical position. Two timber slings, or crosses, were then built and braced inside the ring. Under each end of each horizontal timber was set a screw-jack; the ring was lifted to place with these jacks and the necessary blocking. With this method the ring could be rotated, lowered or raised to bring the studs into the right position for the future erection of the turbine. Four jacks were set inside the form against stiffener webs on the casting to steady the ring. The lower jacks were pipe shoring jacks, which could be concreted in, while the upper pair, which could be taken out, were screw jacks. After the ring was adjusted, the form around it was finished and the concrete poured without danger of throwing the ring out of line.



SHORING JACKS AT TOP AND BOTTOM USED TO ROTATE CASTING

This method was employed in constructing the Five Channels development for the Eastern Michigan Power Company.

DELAYS, INCIDENTAL EXPENSES, high awards and the expense of providing crossings joining severed property were given at the recent valuation conference by Thomas W. Hulme, general secretary of the Presidents' Conference Committee, and real estate agent of the Pennsylvania Railroad, as the four chief reasons why the railroads have found it advisable to avoid condemnation proceedings when any reasonable bargain for needed land can be made.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Proposes Six Viaducts Across River at Los Angeles

Chief Engineer of Utilities Board Presents Plan for Solving City's Grade-Crossing and Traffic-Congestion Problems

Considering the general subject of grade-crossing elimination and the reduction of traffic congestion in the industrial district of Los Angeles, Franklin D. Howell, chief engineer of the Board of Public Utilities of the city, has rendered a report which has been approved by the board. He points out that the city is fortunate in that all of its steam railroads enter the city through the trough of the Los Angeles River, but with railroads at different levels on both sides of the river and bridges across them so placed as to meet only the conditions at those particular sites, he sees danger of a complete shutting off of the river for use, except at the expense of destroying expensive concrete structures. He would, therefore, have an official grade line established along the river bed, with the same elevation on both sides, and would have six viaducts built across the entire valley to carry electric railway and vehicular traffic.

These five objectives are proposed by Mr. Howell:

1. Steam railroad tracks to be at street level, but to cross streets only, and not be granted longitudinal rights along same.
2. Grade to be established along river suitable for railroad grade to accommodate industrial district; railroads now on river banks to be required to conform to same; all structures crossing river to be adjusted to yield standard clearance above or below such grade.
3. Interurban railway to elevate or depress, as the particular locality requires, and to be removed from street surface; such elevated or depressed tracks to lead to suitable terminals, or to a loop subway with no terminal.
4. Street railways to be rerouted, and to use viaducts across industrial district and subways through congested retail district.
5. Viaducts at all principal thoroughfares across industrial district to accommodate vehicles and street cars.

The six viaducts Mr. Howell regards as of immediate necessity would be at Main, Macy, First, Fourth, Seventh and Ninth streets. The approximate lengths would be respectively 6700, 4150, 6100, 6750, 6050 and 5800 ft., making a total of 35,550 ft., and he estimates that they would cost $4,260,000, about $120 per linear foot. He would have the expense divided between city, county, industrial district, street railway and steam railroads, according to one of three schedules submitted.

Floods in Ohio and Missouri Cause Heavy Property Losses

Floods resulting from heavy rains in Ohio and Missouri, July 15 and 16, destroyed property to the value of over two million dollars, crippled railroad services and caused the death of several persons. Lima, Ohio, with a property loss exceeding $500,000, the death of three people and over a thousand driven from their homes probably suffered most. The Ottawa River at this point reached a height, after a rainfall of 4.2 in. in 24 hr., even greater than was reached in the flood of March, 1913. Two bridges were put out of commission and the temporary Pine Street bridge was swept away.

The Scioto River at Kenton also passed the 1913 flood stage, submerging the waterworks and leaving the city without fire protection. At Columbus, high waters in the Olentangy River broke through the levee on the north side and flooded several city blocks. A number of large factories were compelled to remain closed and a thousand men temporarily thrown out of employment.

The Missouri River at Kansas City reached the highest stage yet recorded, except during the flood years of 1903 and 1908. The dikes held well so the damage done was comparatively slight. Railroad service was badly crippled, the estimated damage to tracks and roadbeds, according to reports, amounting to almost a million dollars. The towns of Rosendale, Craig, Wyeth and Corning, Mo., were inundated for over twenty-four hours.

Burlington's Bond Issue Largely for New Bridges

Pres. Hale Holden of the Chicago, Burlington & Quincy Railway announced on July 14 the uses to which the road's new $15,000,000 bond issue will be put. The issue has been approved by the Illinois Public Utilities Commission. Mr. Holden said $500,000 would be used on the Mississippi River division of the Chicago-St. Paul line. One million dollars will be the Burlington's contribution to help build the bridge now under construction across the Ohio River at Paducah, Ky., and $1,000,000 will be spent to elevate the tracks and improve the right of way in Aurora.

Explosion Leaves Grain Elevator Practically Intact

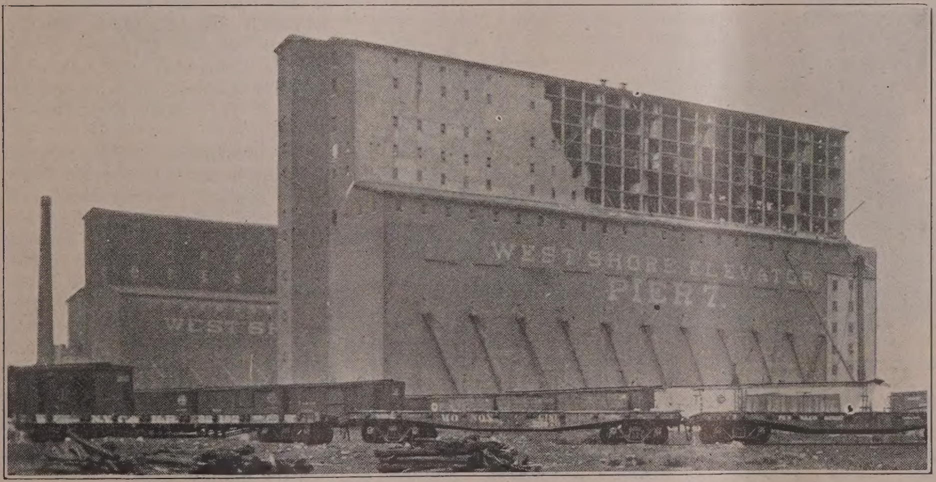
Construction of Building Responsible for Small Extent of Damage—Grain Dust Probable Cause of Explosion

An explosion in the 2,000,000-bu. grain elevator of the New York Central Railroad at pier 7 on the west bank of the Hudson River in West New York, N. J., on the morning of July 15, left the frame, bins and floors of the elevator, as well as the walls of the main structure, practically undamaged. Portions of the tile side walls of the cupola, as shown in the photographs, were blown out, and fell on the side roofs, damaging a few of the purlins. There was no fire, and the damage done to the machinery was negligible. Operation of the elevator was resumed inside of two days, as soon as the débris had been thrown off the side roofs.

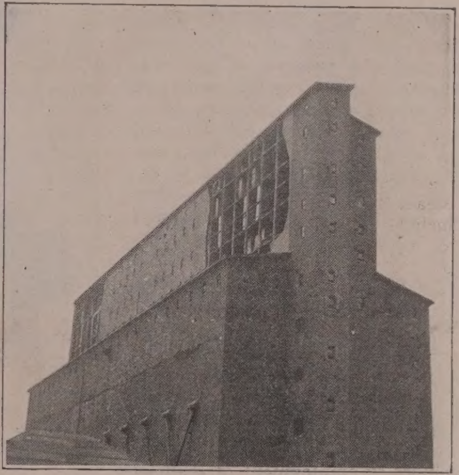
The structural features of this elevator, which was put in service in 1904, were described on page 620 of the Engineering Record of Dec. 28, 1901. The building is of steel frame, with steel-walled cellular bins, and is 196 ft. 4 in. high from the track floor to the roof of the cupola. Its lower walls and the end walls of the cupola are of brick, supported on the foundation, which consists of concrete resting on timber piles driven to solid bottom. The side walls of the cupola are of tile, and are carried on girders which also carry the outside lines of columns of the cupola. The cupola has five floors, which are, from bottom to top, the spouting, motor, scale, garner and machinery floors. Numerous wide openings in these floors possibly permitted the air pressure from the explosion to be transmitted to the exterior walls over their full height, although if only the bottom part of the wall section had been blown out, the wall above would also have fallen.

There was nothing burnable about the building except the grain stored in it, which did not catch fire. The five bins in which the explosion seems to have occurred were undamaged, except that the floor covering the bins was blown off, the whole force of the explosion spending itself in compressing the air confined above the bins and in the cupola, and in throwing down the cupola walls. The whole construction of the building seems to have resisted the explosion very successfully.

No cause for the accident has been assigned, but the ignition of grain dust by a spark of some kind was undoubtedly responsible. Such sparks have been caused by flint pebbles,



THE WALLS BLOWN OUT WITH SLIGHT DAMAGE TO REST OF STRUCTURE



COMPARE WITH PICTURE OF OTHER SIDE

which are sometimes mixed with the grain in threshing, striking the tie rods of the bin cells as the grain is dropped into them. Press reports at first attributed the explosion to a bomb. There was, however, no evidence whatever of local damage near the seat of the explosion. A dynamite explosion would certainly have caused some local damage.

Illinois Takes Up Work on Dixie Highway Link

Illinois officially put its shoulder to the wheel July 14 in the construction of the Dixie highway, designed to link Chicago and St. Augustine, Fla., with a "good roads" thoroughfare. With delegations from practically every city along the proposed route of the Illinois division of the highway between Chicago and Danville in attendance, the first shovelful of earth was turned by "Uncle Joe" Cannon of Danville.

Scope of Present Efforts of Co-operative Committee Outlined

At the informal conference of those interested in engineering co-operation held in Buffalo, N. Y., June 24, a committee of volunteer helpers was suggested and the scope of its work, for the present at least, outlined. In general, it is hoped that each member of the committee will present to his local engineering society the needs and objects of a wider and more effective co-operation in the diffusion of information, employment and legislation. It is the aim to increase the list eventually so as to include an active, energetic man as a representative of each important engineering organization, though as yet the majority of the members have not been designated.

For the present the efforts will be concentrated on a systematic investigation of publicity methods and their results. Later, or perhaps during the progress of this work, steps will be taken to investigate the subject of employment of engineers.

Missionary work has been planned for the purpose of impressing the needs and benefits of co-operation on the members of the various local societies. During the coming winter a series of addresses is planned for important centers of population.

Among those who have already signified their willingness to serve on the committee are F. H. Newell, Urbana, Ill.; H. H. Esselstyn, Detroit; Farley Gannet, Harrisburg, Pa.; Charles R. Gow, West Roxbury, Mass.; A. J. Himes, Cleveland; A. Stuckie, Pittsburgh, and C. E. Drayer, Cleveland, secretary.

Wabash Railroad Sells for $18,000,000 in Foreclosure

The Wabash Railroad, which has been in the hands of receivers for three years, was sold at public auction July 21 at St. Louis to satisfy a $41,000,000 mortgage. The property, capitalized at $220,000,000, was bid in at $18,000,000 by representatives of the creditors' committee. In the reorganization that is now to proceed it is understood that the stock is to be assessed $30 per share.

Decrease in Cement Production During 1914 First Yet Recorded

A large falling off in the production of Portland cement and a still larger reduction in shipments, as compared to the corresponding period of the preceding year, occurred in the latter part of 1914, according to reports of the U. S. Geological Survey, and the net result for the year was a slight decrease both in production and shipments. Owing to the fact that the cement industry is particularly subject to local conditions the depression was not felt to the same extent in all sections of the country. The Gulf and Rocky Mountain States, for instance, where progress was checked by agitated industrial conditions, present a marked contrast to such States as New York, Pennsylvania, Ohio, West Virginia and Michigan. Although no statistics are available for the first half of 1915, it is believed that, as compared to 1914, there has been no appreciable loss or gain and that, if no unforeseen conditions arise to seriously affect business, the next six months should show an improvement.

Flood-Preventing (?) Bulls

Flood prevention studies have occupied much space in engineering literature during the last few years, but it remained for Prof. Daniel W. Mead, of Madison, Wis., to reveal to Occidental minds one of the oldest of flood prevention methods—or, rather, supposed flood prevention methods. When the commission of engineers investigated the Chinese flood situation last year, under the auspices of the American Red Cross, the members learned that over seven centuries ago, when the Chinese constructed the great Ming dike, thirty-five miles in length, to protect the plains of Southeastern Kiang Su, eight cast-iron holy bulls were placed on top of the dike as an additional precaution to stop the floods. Immediately after the placing of the bulls the floods ceased—a clear proof (to the natives) of the efficiency of the bulls. A century or two later, however, another tremendous succession of floods occurred, and upon examination it was found that some sacrilegious wretch had stolen the golden heart and silver entrails of the bulls. The images therefore, having been desecrated, could not longer be expected to perform their proper functions. They were, therefore, replaced by a second, and later by a third generation of bulls.

THE CHINESE EXPECTED THIS BULL TO STOP FLOODS

Professor Mead told the story before the Ohio Senate committee on drainage and irrigation, when amendments to the conservancy law of Ohio were up for discussion in March of this year. He aptly turned the story into a telling point against the amendments, by pointing out that the methods they would compel the valley to use would be no more feasible for flood protection than were the holy bulls of China.

As has been recorded in this paper the amendments were successfully resisted and as a memento of the occasion, E. A. Deeds, vice-chairman of the Flood Prevention Committee and director of the Miami Conservancy District, had small replicas of the bull cast and distributed, with copies of Professor Mead's speech, to those who had labored in the interest of the conservancy act and the Miami Valley project.

Illinois Highway Commission to Spend $990,000

The Illinois Highway Commission will distribute $990,000 among the various counties of the State for road improvement work during the year 1915-16. The allotment which was made July 15 shows that Cook County receives the largest sum—$108,994. Each county under the "Tice Law" has to put in an amount equal to that given by the State in order to obtain State aid.

Will Give Summer Course in Scientific Management

Pennsylvania State College will conduct a summer school of scientific management during the two weeks beginning Aug. 9. The session is planned for the accommodation of works managers, superintendents and other members of industrial organizations, and the time is restricted to two weeks to meet the needs of employees whose vacation periods are limited to that length of time.

The mornings will be devoted to lectures and discussions on industrial organization and scientific management under the leadership of Prof. Hugo Diemer, head of the Department of Industrial Engineering at the college. Professor Diemer has had charge of similar courses at the University of Chicago this summer. He has been superintendent of the National Motor Vehicle Company, and has done advisory work in planning organizations for various industrial plants.

The afternoons will be devoted to actual practice in applied methods of scientific management, and in the making of time studies, tool lists, instruction cards, routing and scheduling under the direction of W. H. Tabor, of the Tabor Manufacturing Company, which company has been credited with the most completely developed shop under scientific management in America. The shops of the Pennsylvania State College have been specially provided with means for teaching and demonstrating applied methods of scientific management.

The fee for the course is $15. Persons who are interested in taking the course are requested to apply at once to J. A. Moyer, director, State College, Pa.

Water Rate Fight Settled at Lake Forest, Illinois

Residents of Lake Forest, Ill., have won their long fight to reduce the rates of the Lake Forest Water Company. The Illinois Public Utilities Commission has ruled to cut the rates to consumers from 25 cents per 1000 gal. to 18 cents. Twenty cents per 1000 gal. was the rate for which the Lake Foresters contended. The old rate of $40 per 500 ft. of main for hydrant purposes remains unchanged.

Southern Pacific Acquires Five Oregon Lines

Five subsidiary lines of the Southern Pacific Company on the Pacific Coast, heretofore operated as separate corporations, were formally taken over as a part of the system on July 1. Directors of the several companies voted for the consolidation at the last annual meeting.

The railway lines absorbed include the Portland, Eugene & Eastern Railway; Coos Bay, Roseburg & Eastern Railway & Navigation Company; Salem, Falls City & Western Railway and the Pacific Railway & Navigation Company.

N. Y. Board of Estimate Approves Tunnel for Subway to Queens

At a special session on July 21 the New York City Board of Estimate unanimously adopted the alternate tunnel plan proposed to carry the Fifty-ninth Street subway traffic under the East River to Queens Borough. The other plan, which was definitely abandoned by the resolution as offered by President McAneny, provided this connection by remodeling the Queensboro Bridge. Although this action carried a notification to the Public Service Commission that the Board believed the tunnel should be built and was prepared to supply the funds, based on the $4,500,000 bid promised by the Degnon Contracting Company, the final decision depends upon the approval of both bodies.

The alternate estimates comparing the two plans showed an excess cost of the tunnel over the bridge plan of $1,937,000, or if cost of dredging on the Queens side be included, the total difference is $2,237,000. To offset this, the people of Queens claim there will be greater freedom of the bridge for vehicular traffic.

Order for Accident Compensation on Alaska Railways Approved

President Wilson approved the order covering compensation for accidents on the work of constructing the Government railways in Alaska, July 20. The system adopted is an extension of the act covering the Panama Canal, the Reclamation Service and the Bureau of Mines. It provides that employees of the Alaska Engineering Commission shall be entitled to receive compensation for injuries sustained in the course of their employment while actually in Alaska and that all claims resulting from such causes shall be settled by the chairman of the commission, providing, in case any such accidents result in death, that the claims shall be filed with him within a year after it occurs. No charge will be made for medical service to an employee thus injured and in case it is necessary or beneficial that the injured person should be conveyed to any other point in Alaska, or to Seattle, for treatment not available where the injury occurs, the cost of transportation will be borne by the commission.

Engineering Congress Issues Program of Society Conventions

The International Engineering Congress has issued a program which covers in outline the conventions of four of the National engineering societies at San Francisco, the meetings of the congress and the excursions to various points of engineering interest that have been planned, and gives information as to special trains, hotels and services of congress committee on local affairs. The booklet may be obtained from W. A. Cattell, secretary of the International Engineering Congress, Foxcroft Bldg., San Francisco.

Federal Trade Commission to Aid in Lumber Inquiry

The Federal Trade Commission has announced its intention to co-operate with the U. S. Forest Service and the Bureau of Foreign and Domestic Commerce in their study of the lumber industry. The purpose of the inquiry will be to make it of benefit to all branches of the lumber industry as well as to consumers. Conditions in the trade have changed in recent years due to the widespread use of other structural materials than wood, and, on the assumption that lumbermen are confronted with many problems, not fully understood by them and seldom appreciated by the public, the inquiry will make it its object to ascertain the facts and to put them before the people with the authority of a fair and unbiased investigation and to find practical and constructive suggestions looking to the improvement of existing conditions.

Personal Notes

L. E. Tuttle has been elected assistant city engineer of Stamford, Conn.

D. C. Wrighter has been re-appointed city engineer of Lewiston, Idaho.

John Shaw has resigned from the office of town engineer of North Bay, Ont.

Edmund B. Ulrich has been re-elected city engineer of Reading, Pa., for a term of two years.

Henry Hadley, Jr., city engineer of Verdun, Que., has resigned to go to the front in the European war.

A. L. Smith has been appointed resident engineer of the State Highway Department of Alabama, at Selma.

E. F. Ayres has been appointed resident engineer for the Oregon State Highway Commission, at Sherwood, Ore.

E. C. Buckland has been appointed president of the Central New England Railway, succeeding Howard Elliott, resigned.

E. F. Booth, formerly assistant city engineer of Youngstown, Ohio, has resigned to engage in the contracting business.

J. B. Trenholm has been appointed engineer of roadway of the Atlantic Coast Line Railroad, with office at Rocky Mount, N. C.

N. C. Ray has been appointed senior civil engineer for the Pacific district, Interstate Commerce Commission, Division of Valuation.

H. McAuslan has been appointed town engineer of North Bay, Ont., succeeding John Shaw, whose resignation is noted elsewhere in these columns.

G. E. Buckley, formerly engineer maintenance-of-way for the Southern Railway, at St. Louis, has been appointed engineer maintenance-of-way at Richmond, Va.

R. H. Gould, of the staff of James H. Fuertes, consulting engineer, of New York City, has been appointed resident engineer on the new sewage disposal plant at Dallas, Tex.

E. M. French has been appointed assistant on the engineering forces of the Erie and Ashtabula division of the Pennsylvania Railroad.

George W. Supplee has been appointed junior assistant on the engineering forces of the New York State Public Service Commission, First District.

Carl H. Watson, civil engineer of Great Neck, L. I., has been appointed supervising engineer of the Port Washington (L. I.) sewer district. Work on designs will be started immediately.

Ambrose M. White, formerly assistant engineer of the paving commission of the City of Baltimore, is now connected with the engineering forces of the Pennsylvania State Highway Commission.

Warren Travell, formerly engineer for the Tennessee Natural Development Company, of New York City, has been appointed construction engineer for the Atlas Portland Cement Company at Northhampton, Pa.

Eugene Somers, formerly assistant engineer with Ward Carpenter & Company, civil and consulting engineers, of New York City and Tarrytown, N. Y., has been appointed assistant city engineer of Woonsocket, R. I.

H. E. Tyrrell, formerly supervising engineer for the Southern Railway at Washington, D. C., has been appointed engineer maintenance-of-way at St. Louis, succeeding G. E. Buckley, whose transfer to another post is noted elsewhere in these columns.

Harold G. McGee, acting medical inspector in the office of the State sanitary engineer, Michigan State Board of Health, has been appointed sanitary engineer for the city of Jackson, Mich. Mr. McGee, who was graduated from the University of Michigan in 1913, was an assistant engineer in the Ohio State Board of Health from Oct. 1, 1913, to Dec. 31, 1914.

Edwin C. Hamilton, for the past two years connected with the U. S. Engineers Office at Louisville and previous to that district geographer for the U. S. Forest Service, at Albuquerque, N. M., has been transferred to the office of the surveyor-general of Alaska, at Juneau.

William Bowie, inspector of geodetic work of the U. S. Coast and Geodetic Survey, who was recently elected treasurer of the Washington Academy of Sciences, is conducting the course in geodetic surveying and practical astronomy for the summer school of Columbia University at the camp near Litchfield, Conn., in conjunction with C. A. Mourhess, computer, also of the U. S. Coast and Geodetic Survey.

H. E. Tanner has been appointed city engineer of Verdun, Que., succeeding Henry Hadley, Jr., whose resignation is noted elsewhere in these columns. Mr. Tanner was assistant to the town engineer of Chicoutimi, Que., for two years and had three years experience on the engineering forces of the Transcontinental Railway. Recently he has been engaged in metallurgical research work at the Institute of Technology, Pittsburgh.

Matt M. Bird, consulting civil engineer, who has recently been in charge of street paving at Lewisburg, Tenn., has moved his office to the Blount Building, Pensacola, Fla. He was graduated from the University of Tennessee in 1911 and from Cornell University in 1912. Before graduation he was engaged in various capacities on several engineering jobs. In 1912 he went to Cuba and was there employed by Ruiz & Taylor, engineers and contractors, on railroad location and construction. Since returning to the United States he has been employed principally on municipal improvements.

F. C. Hand, consulting engineer, of Purcell, Okla., and formerly chief engineer of the Oklahoma Central Railway, is now with the Rock Island Lines, engaged in the Federal valuation work. He received his professional education at Union College and entered railway service as rodman on the Texas Western Narrow Gauge Railroad. He was appointed assistant engineer on the Ohio River Railroad in 1883 and chief engineer of the Tavares, Orlando & Atlantic in 1884. During the Spanish-American war he served as a captain of engineers, U. S. V., and in 1899 was appointed chief engineer of the Twin City Railway between Dallas & Fort Worth, Tex.

William C. Downing, formerly general superintendent of the Central system of the Pennsylvania Lines West of Pittsburgh, has been appointed general superintendent of the Northwest system. He entered railway service in 1885, as rodman on the engineering forces of the eastern division of the Chicago, St. Louis & Pittsburgh, attained the grade of assistant engineer in 1888 and that of engineer maintenance-of-way in 1891. He was appointed superintendent of the main line division in 1902 and superintendent of the Pittsburgh division of the Pittsburgh, Cincinnat, Chicago & St. Louis in 1912. He became general superintendent of the Central system of the Pennsylvania Lines West of Pittsburgh in 1914.

Frank E. Winsor, department engineer of the Board of Water Supply, New York City, has been appointed chief engineer of the Board of Water Supply of Providence, R. I., in which capacity he will have charge of the development of the new water supply at Scituate. He was graduated from Brown University in 1891 and served until 1895 as transitman on preliminary surveys and construction on the forces of the Metropolitan Sewerage Commission of Massachusetts. Since then he has had an extensive experience in waterworks design and construction and in water supply problems, principally in New York State and in Massachusetts, in connection with the Catskill Aqueduct the Weston Aqueduct and other works.

Prevost Hubbard has resigned from the office of chemical engineer, in charge of the division of roads and pavements of the Institute of Industrial Research, to become chief of the division of road material tests and research in the U. S. Office of Public Roads and Rural Engineering. He began his professional work as chemist for an ammonia company in 1900 and served as assistant in timber testing for the U. S. Bureau of Forestry from 1903 to 1905. He was appointed assistant chemist in the Office of Public Roads in July of the latter year and chief chemist, in which capacity he was engaged exclusively on chemical investigation of road and paving materials of practically all types in 1910. He was appointed director in charge of the division of roads and pavements of the Institute of Industrial Research in 1911.

R. W. Rea, formerly chief engineer of the Cascade irrigation district at Ellensburg, Wash., has been appointed chief engineer of the Coast Culvert & Flume Company, of Portland, Ore. He was graduated from the Michigan College of Mines in 1900 and was engaged in various capacities for mining companies at Redridge, Mich., until 1902. He served as assistant engineer in the office of the city engineer of Spokane in 1906, and as resident engineer with Earnest B. Hussey, consulting engineer, of Seattle, Wash., from 1907 to 1909. In 1910, as chief engineer for the Craig Mountain Lumber Company, of Winchester, Idaho, he made a survey for an irrigation project and designed and constructed a water and fire protection system for the town of Winchester. He was appointed assistant engineer of the Kittitas Reclamation District in 1911 on estimates, canal location and land classification, and, in 1913, chief engineer of the Cascade district in charge of the design and construction of improvements to the Cascade canal, including the relocation and reconstruction of about ten miles at a cost of about $360,000. In his new capacity he will have charge of the enlarging of the plant of the Coast Culvert & Flume Company to practically double its present capacity.

Farley Gannet has resigned from the office of engineer of the Water Supply Commission of Pennsylvania to engage in private practice as consulting engineer, specializing on cases before the State departments and commissions, including the Water Supply Commission, the Public Service Commission and the health and highway departments. His office will be in Harrisburg. He will engage in a general practice as well, and is organizing a force for this purpose. A chemical and bacteriological laboratory has already been established, with an experienced bacteriologist in charge, to handle analyses of water, sewage and trade wastes. Mr. Gannet was graduated from Massachusetts Institute of Technology in 1902 and was engaged under James H. Fuertes, of New York City, on the surveys and design of a 3-mile intercepting sewer at Harrisburg and as inspector of construction of twelve pipe sewers. In 1904 he was appointed assistant engineer on the design of a mechanical filtration plant for the same city, under the immediate direction of Charles G. Hyde. He was appointed engineer of the State Water Supply Commission in 1905. In the course of the ten years that he has occupied the office the commission's engineering force has been increased from two to fifty men and the reports have grown from paper covered pamphlets to volumes containing 800 to 1000 pages. The Pennsylvania stream-gaging survey and methods were initiated by Mr. Gannet in 1907 and the State laws for the supervision of streams are mostly the result of the work of his office. He has been desirous of entering the consulting field for several years but was restrained from resigning by the request of the late John Birkinbine, who was the chairman of the commission. Mr. Gannet is president of the Engineers' Society of Pennsylvania.

Obituary Notes

O. W. Jasper, well known in civil engineering circles on the Pacific Coast, died recently at Sacramento, Cal., aged 57 years. He was a graduate of the University of California, was engaged at various times in important railroad engineering projects, having been division engineer during the construction of the Western Pacific from San Francisco to Fresno, and chief engineer for the Northern Electric Railway during the construction period.

Frank R. Williamson, for the past six years assistant engineer with the Chicago Sanitary District, died in Chicago, July 11. He was born in 1867 and was graduated from the University of Illinois in 1892. His first service was with the Pittsburgh Bridge Company as draftsman and checker in the Chicago and Pittsburgh offices. In 1895 he was with Ralph Modjeski, assisting in the design of the draw span of the Rock Island Bridge across the Mississippi River. From 1897 to 1898 he was with the Chicago Drainage District, computing the strains for eight of the largest draw spans over the Drainage Canal, and assisting the bridge engineer. Then for two years he did bridge work for various companies, and in 1901 was appointed assistant engineer in charge of the drafting department of the Scherzer Rolling Lift Bridge Company. His last service was with the Sanitary District.

Civil Service Examinations

United States.—The United States Civil Service Commission will hold an examination for ordnance draftsmen, entrance salaries ranging from $3.28 to $5.04 per day, Aug. 4 and 5.

Examinations will be held Aug. 17 and 18 for senior, Grades 1 and 2, and junior land appraisers respectively, in connection with the Interstate Commerce Commission's valuation work on common carriers. The salaries are to be from $2,700 to $3,600 a year for Grade 1, and from $1,800 to $2,400 a year for Grade 2, senior appraisers, and from $900 to $1,500 a year for junior appraiser. Applicants for senior appraiser, Grade 1, must be 30 years or over; for Grade 2, 25 years or over, and for junior appraiser, 21 years or over. Application should be made at once for Form 1312, stating the title of the examination for which the form is desired, to the U. S. Civil Service Commission, Washington, D. C., or the secretaries of civil service boards at the post-offices of the principal cities.

Philadelphia.—The Civil Service Commission announces examinations as follows:

August 6—Tracer, salary $600-$900 a year; applicant must be 18 years or over. Rodman, salary $800 a year; applicant must be 19 years or over.

August 9 and 12—Draftsman, surveys, salary $1,200-$1,500 a year; applicant must be 20 years or over.

August 10 and 13—Draftsman, highways, salary $1,200-$1,500 a year; applicant must be 20 years or over.

These examinations are open only to citizens of the United States and residents of Philadelphia. Application should be made immediately to the Civil Service Commission, Room 875, City Hall.

Examinations Previously Announced

Date	See Eng. Record
July 31—Assistant Engineer, water power, storage and drainage, New York State Conservation Commission	July 3
Sept. 15—Aid, U. S. Coast and Geodetic Survey. Draftsman and junior engineer, U. S. Engineer Department	July 3
Oct. 13—Aid, U. S. Bureau of Standards. Civil Engineer and Draftsman. Draftsman, Navy Department. Engineer, Indian Service	July 3

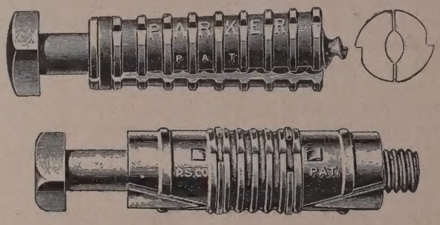
Control of Excavator and Loader Passes to New Hands

Exclusive manufacturing and selling rights of the Albrecht excavator and loader have been acquired by the T. L. Smith Company of Milwaukee, thus marking the entrance of this prominent concrete mixer company into the dirt-moving field.

The inventor of the machine, John H. Albrecht, has been developing the machine for over five years. A number of them have been sold and their performance has been such as to lead the T. L. Smith Company to believe that a very large business can be developed in this line. As has been described in this journal (July 19, 1914, Current News Section) the Albrecht excavator and loader is a combination scraper, excavator and wagon loader, suitable for the excavation of large foundations, basements and drainage ditches, for backfilling, loading sand and gravel, etc. It will dig at a distance of 100 ft. from the machine and at any desired depth for ordinary excavation at the rate of one round trip per minute. One of the largest fields expected for it is on highway excavation work, replacing the usual horse scraper. The machine carries a 12-hp. gas engine, providing power to dig and load 20 cu. yd. per hour.

Lugs on New Expansion Bolt Prevent Twisting

Lugs to prevent it from turning are the feature of the new type of expansion bolt which the Parker Supply Company, 527 West Twenty-fifth Street, New York City, has recently placed on the market. The projections are reversibly directed, as shown in the cross-section in the accompanying illustrations, and effectively prevent both right and left hand movements. The circumferential ridges insure a proper resistance to stress in the direct line of the bolt.



RIDGES RESIST DIRECT LINE STRESS

The steel spring band on the second type of bolt manufactured by the company holds the halves together and is claimed as a noteworthy improvement. The spring band, on account of its flexibility, allows the shield to expand freely. Both types of bolt, it is stated by the manufacturer, are made of malleable iron of the finest quality to insure the maximum strength of casting.

Asbestos Brake Block Outlasts Several Sets of Wood Blocks

An asbestos-metallic brake block that showed only 0.04 in. wear after five months of service on a heavy duty coal hoist on which wood blocks lasted only a few days, has been put on the market by the H. W. Johns-Manville Company, Madison Avenue and Forty-first Street, New York City. It is a hard, tough, homogeneous material, dark gray in color and fibrous in structure, that is claimed to have a gripping power such as to afford perfect braking control and to produce but a very slight wear on the brake facings. It is asserted to be absolutely uninflammable, to be free from deterioration due to frictional heat and to be unaffected by oil, water or climatic conditions. Its record during the past months in service indicate that it will outlast six to ten sets of wood blocks.